

SOUTHERN HEMISPHERE
METEOR RATES

By

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FINAL REPORT.
RESEARCH GRANT NGR-52-052-001

The research reported in this Document has been Sponsored by
OFFICE OF SPACE SCIENCE AND APPLICATIONS
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON D.C. 20546

DECEMBER 1968.

PHYSICS DEPARTMENT
UNIVERSITY OF NEWCASTLE
N.S.W. 2308, AUSTRALIA

ABSTRACT

The complete meteor rate data is presented from a controlled-parameter radar survey of meteor activity in the southern hemisphere. The survey extended continuously for 31 months from February 1963 until August 1965 inclusive. The data has been very thoroughly screened and the meteor rates presented in tabular form cover almost ninety per cent of the survey period. The tables contain a total of 2,304,333 meteors, an average of 114 per hour.

The average diurnal variation in meteor activity is exactly similar to that obtained in an earlier survey in 1960/61 but some changes are evident in the annual variation. The various factors which influence the observed meteor rates are discussed.

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1. INTRODUCTION

During the period between 1 February 1963 and 31 August 1965, inclusive, a radar meteor rate survey was carried out from a radar installation near Christchurch, New Zealand ($43^{\circ}37'S$, $172^{\circ}24'E$). The equipment used was the same, except for a few improvements, as that used for an earlier survey from 1 February 1960 to 31 January 1961, inclusive (Ellyett & Keay 1961, 1963).

The second survey was maintained for a duration of 31 months, as against 12 months for the first survey, and the extended results have verified many of the findings of the earlier survey, while revealing some important differences. For example, the differences in meteor rate from year to year can be very great (Ellyett & Keay, 1964) and are principally caused by variations in the density of the upper atmosphere produced by solar influences (Ellyett, 1968).

Another meteor rate survey using somewhat similar equipment has been conducted in Canada since 1957. The data from 1958 to 1962 has been published (Millman & McIntosh, 1964, 1966) and later results, extending over the period covered by the second New Zealand survey described herein, are at present being analyzed and prepared for publication. The two sets of data, covering opposite hemispheres, will complement each other.

2. EQUIPMENT

The Christchurch rate-measuring radar equipment was substantially unchanged from that used in the earlier survey. It has been fully described (Ellyett & Keay, 1963) but the important parameters are:

Frequency:	69.5 MHz
Pulse Width:	26 microseconds
Peak Pulse Power:	81 kilowatts
Pulse Repetition Frequency:	150 per second

The transmitter pulses were approximately square with rise and fall times less than 10% of the pulse width.

A crossed, folded dipole antenna was used for transmission and an identical one, a quarter of a mile distant, was used for reception. Both antennas had omni-directional radiation patterns in azimuth and identical vertical patterns with a maximum power gain of 3.8 over isotropic at an elevation of 55 degrees.

The receiver was designed for low noise, and as will be shown in Section 8, galactic noise set the limiting meteor magnitude detectable by the equipment. The limiting magnitude is close to +8.0.

The output from the receiver modulated the intensity of a linear trace on a cathode ray tube. The trace was continuously photographed on 35 mm film with adjacent images of a clock and a detector current meter recorded every three minutes.

Every fifteen minutes an additional meter showing the field strength of the transmitted radiation was photographed onto the film record. When variations in radiated power greater than 20 per cent occurred the records were usually rejected (see Section 4). Power fluctuations of 8 to 10 per cent normally occurred within a 24-hour period despite the provision of active regulators on the A.C. supply to the transmitter (refer Ellyett & Keay, 1963).

For a few seconds every hour the antenna input was automatically switched to an internal noise generator. The noise diode current was switched through the power level meter and its readings, together with those of the detector current meter were photographed onto the film record. In practice this only served to indicate that the receiver performance remained normal during periods when external man-made noise exceeded the galactic noise level. During such periods the records were usually rejected as described in Section 4. At most other times the detector current reading alone provided adequate assurance of correct receiver operation.

3. SYSTEM OPERATION

The radar system was operated for 24 hours a day. The only interruptions were those caused by equipment malfunctions and regular maintenance periods twice a week. During maintenance shutdowns, which usually lasted less than an hour, the film was replenished in the camera and any necessary adjustments were made to maintain all parameters constant.

Throughout the survey the equipment was in operation for almost 95% of the total time and the final data coverage is almost 90% complete. The month-by-month percentages of data in the meteor rate tables are shown in Figure 1. An exceptionally high loss of data occurred in September 1964 because of problems with a faulty set of replacement transmitting tubes. During that month the equipment was in operation for only 71 per cent of the time.

The three factors which contributed to loss of data are plotted in figure 2, and described in the following Table:

FACTORS CAUSING LOSS OF DATA	REGION IN FIGURE 2	PERCENTAGE OF TOTAL SURVEY TIME
System not in operation	Dotted	5.27
Film records contaminated by noise	Cross-Hatched	2.33
Data rejected for other reasons	Unshaded	2.95
		<hr/> 10.55 <hr/>

The contamination of film records by noise was principally due to R.F. interference originating from the A.C. supply mains. Bad insulators and faulty jumper connectors on the local 3.3 kv feeder caused discharges which produced high R.F. noise levels. Periods of complete freedom from such noise were often noted following rainfalls which washed clean the feeder insulators.

Other reasons for data rejection varied greatly. They included occasional faults in film processing; evidence of temporary reductions in transmitted power; changes in voltage standing wave ratio on the open-wire transmission lines; and other variations in system performance which were sometimes inexplicable. The criteria used for deciding to reject data are discussed in the next section.

4. DATA QUALITY CONTROL

The data on the film records was transferred to suitable data sheets by a team of trained film readers. Their performance was kept standardized to better than ten per cent by frequent re-reading of samples of film by one of the authors (C.S.L.K.), or one of the film readers whose interpretation was consistently accurate. This procedure was considered to be better than the determination and application of personal equations for each individual reader because the reading interpretation of most of the readers, particularly the least experienced, varied from week to week by a far greater amount than the variation between the most experienced and consistent readers.

Whenever the film records were contaminated by any form of R.F. interference a note of the fact was made in a comments column on the film-readers' data sheets, but meteor-echo counts were still obtained if at all possible. These counts were subsequently accepted or rejected when the data quality was evaluated by the authors.

All of the meteor-echo counts obtained during the survey, together with the accompanying meter indications of radiated power, receiver sensitivity, etc., were scrutinized by the authors in an effort to guarantee the constancy of equipment performance for the data accepted and eliminate spurious echo rate fluctuations. Data which was suspect for any of the reasons mentioned earlier was rejected.

If the half-hourly meteor counts differed by more than 50 per cent from values at the same hour on both adjacent days the data was rejected. Quite often the film records were re-analyzed independently by another reader before a decision was made to accept or reject the data.

Simple averaging techniques were employed to restore data whenever less than 30 per cent was lost or had to be rejected within any half-hour period. The meteor echoes were counted over three-minute intervals during the film-reading. Normally ten of these counts were added to yield a half-hourly meteor count. Provided at least seven three-minute meteor counts were obtained or considered acceptable the total (less unacceptable counts) was adjusted by the factor $10/n$ where n is the number of three-minute counts added to form the total. The adjusted totals were treated no differently from the unmodified totals when scrutinized during quality evaluation by the authors.

The same procedure was employed whenever necessary to adjust the half-hourly averages of the detector current readings.

5. DATA SCALING

On two occasions during the survey it was necessary to apply a scaling factor to blocks of degraded data in order to make them acceptable. This was only done when the reason for the degradation was known and an appropriate scaling factor could be derived. Otherwise such data was rejected.

The first occasion occurred in December 1963 when the camera aperture setting was inadvertently altered. The resultant under-exposure of the film record was noticed when the film was developed and the condition was then immediately corrected. The fault occurred on December 2 and was corrected on December 9, affecting eight days of records.

The second occasion occurred in November 1964 when one film was insufficiently developed. The film was very light in density and all faint meteor echoes were lost. This affected four days of data, from November 6 to November 10.

In both cases the films were read as carefully as possible and the half-hourly meteor rate values were found to be about half of what they should have been. In the case of the under-developed film in November 1964 the data scaling factor was found quite simply by plotting the hourly meteor counts during the four day periods preceding and following the period affected. A mean was obtained and compared with the mean value for the corresponding hours of the four days affected. These ranged from 1.54 to 2.66 and gave an average of 2.06. This was adopted as the scaling factor. The scaled mean hourly rates are plotted in Figure 3, together with the mean values obtained from the films immediately preceding and following the underdeveloped film.

The above procedure was considered to be valid because the meteor rates during early November do not usually include much shower activity and vary very little over the twelve days considered, as may be seen from Figure 3. However the situation in December is complicated by an increasing level of activity during the period affected. For example, the mean daily total of meteors for the week following the affected period was higher than for the week prior to the affected period by a factor of 1.28. In this situation the manner in which the meteor totals varied throughout the period must be known before a valid scaling factor can be derived.

The method adopted relied upon a comparison with the daily rates obtained during the corresponding period in December 1960. For each day from November 25 to December 16 inclusive, the ratio was obtained of the daily rate in 1963 to that in 1960. During the week December 2-9, when the 1963 rate was affected, the average 1963/1960 ratio was 0.697 compared with averages of 1.088 and 1.301 for the preceding and following weeks respectively. The mean 1963/1960 ratio for the unaffected data was therefore 1.194, which yielded a scaling factor of $1.194/0.697 = 1.71$ to be applied to the data affected by the incorrect camera stop setting.

The scaling factor of 1.71 was adopted and applied to the affected data before any results from the same period in 1964 were available. However, an identical analysis, comparing the 1963 and 1964 rates, produced a scaling factor of 1.60. As the difference is less than seven per cent it was not thought worthwhile to further correct the situation.

In the monthly tables of hourly meteor rates presented in Section 6 the scaled values are marked by an asterisk.

6. METEOR RATE DATA

The hourly all-sky meteor rates obtained during each month of the 1963-65 survey are given in the following 31 pages. Only the finally accepted rates are listed. A summary of the monthly meteor totals and number of half-hourly counts is included following the meteor rate table for August 1965.

Universal Time is used throughout. The longitude of the observing station ($172^{\circ}24'E$) is such as to lead to a simple relation between the systems of time measurement, as follows:

$$00^h00^m \text{ U.T.} \equiv 12^h00^m \text{ N.Z.S.T.} \equiv 11^h30^m \text{ L.T.}$$

This fortuitous relationship was exploited in the computer analysis by storing the data as half-hourly values which could be combined in pairs to produce hourly rates in any of the three time systems as desired.

The meteor rate data obtained during the 31 months of the survey is presented in Figure 4 in the form of a contour map which reveals the average annual and diurnal variations in meteor activity. This presentation reveals the main features of the meteoroid influx on the Southern Hemisphere of the Earth down to the limit of particle size detectable by the equipment. As it represents the average of over two years of observations, and because it shows contours at twice the spacing, it exhibits less fine detail than the corresponding map for the 1960/61 survey data (Ellyett & Keay, 1963, page 344). However, all of the significant features detected by the 1960/61 survey may be discerned in Figure 4 and this would include the weak activity in October if the intermediate contours were shown.

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN..																								CHRISTCHURCH, NEW ZEALAND											
FEBRUARY 1963																																			
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS									
DAYS		DAYS																																	
01				93	87	70	48	43	56													149	166	164	01										
02	153	111	121	84	81	62	58	34	38	42	64	68	116	115	143	127	118	129		156	162	139	148	118	02										
03	163	131	117	88	75	36	55	39	51	59	54	63	101	102	119	120	129	144	129	121	125	130	129	83	03										
04	125	105						33	33	42	57	70	97	103	119	105	112	106	105	121	134	108	127	102	04										
05	117	118	103	91	80	59	46	38	48	42	71	61	100	96	98	98	95	113		120		143	143	121	05										
06	109	109	98	85	65	51	42	47	56				88	113											06										
07	71	122	87	71																					07										
08				126	110	75	81	72	71	78	77	109	145	170	147	159	182	166	170	180	172	153	189	195	08										
09	173	182	148	103	105	84	67	73	75	88	71	107	105	151	144	160	159	166	171	170	196	181	160	137	09										
10	167	165	134	151	119	93	83	73	87	88	86		127	118	137	134	165	176	149	182	175	174	179	163	10										
11			129	100	94	84	61	61	77	85	80	91													11										
12						53	72		54	73	102	123	151	154	159	153	170	169	154	182	175	175	178	149	12										
13	184	173	144	88	97	84	75	79	83	82	100	107										196	176	188	13										
14	162	156	154	119	104	89	83	78	82	74	89	86	103	118	127	150	198	188	167	173	206	170	178	162	14										
15	142	134	123	133		62	47	45	56	46	86	91	89	130	143	164	145	145	171	138	187	178	153	153	15										
16	123	130	119	77	74	52	48	55	36	63	67	83	117	138	139	143	158	153	165	161	163	181	179	147	16										
17	151	130	126	112	107	63	59	42	56	71	74	105	112	91	121	117	149	156	158	168	180	163	161	154	17										
18	150				90	52	55	43	54	51	66	94	127	147	168	161	140	139	136	168	166	156	158	153	18										
19	167	189	137	92	74	58	56	63	68	90	90	97	128	143	169	197	214	194	193	178	202	199	204	179	19										
20	178	140	134	138	88	77	64	65	64	82	80	115	132	166	151	176	162	144	146	156	170	153	192	196	20										
21	169	141	124	101		74	50	59	62	65	86	103	111	130	152	174	153	176	145	144	177	177	129	145	21										
22	118	128	109	82																					22										
23			104	97	80	69	59	61	53	86	98	105	112	140	175	179	157	154	168	149	178	177	179	150	23										
24	170	119	134	117	76	51	57	65	60	55	94	107	134	138	147	175	170	150	200	176	163	154	133	24											
25	117	147		77	87	66	67	70	81	108	120	133	168	153	191	169	189	163	173	155	196	170	147	152	25										
26	158	146	139	119	105	91	77	79	89	118	105	130	152	166	140	175	165	169	166	187	190	182	179	207	26										
27	138	139	139	100	93	86	77	95	108	112	104	125	139	164	181				212					192	27										
28	187	197	165	128		64	54				75	85	113	142	117	127	146	105	106	84	171	145	153	146	28										
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS									

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN..													CHRISTCHURCH, NEW ZEALAND												
MARCH 1963																									
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
01	150	123	109	91	68	50										135	147	128	128	135	134	169	158	155	01
02	115	127	127	109	63	52	51			39	61	73	85	115	100	125	104	136	107	121	146	179	164	163	02
03	140		118	88	82																				03
04				138	119	86															153	215	178	233	04
05	221	174	170	153	110	86													137	111		197	205		05
06	186	162	136	118	92																				06
07							30	45	36	51	59	78	71	93	91	83	80	100	82						07
08																									08
09																									09
10																									10
11							71	57	55	94	84	107	131	143	167	141	144	161	161	146	165	184	174	176	11
12	182	145	151	89	87	56	64	76	72	97	115	131	140	131	140	151	145	152	167	137	150	150	168	196	12
13	188	156	128	127	115	72	79	63	81	80	111	127	127	126	144	149	127	127	137	148	186	164	185	154	13
14	179	149	146	120		76	45	53	60	59	90	121	113	138	153	160	140	128	145	134	164	160	152	129	14
15	124	120	87	59	49																				15
16						35	35	41	41	44	58	69	91	85	109	100	99	82	83	111	110	111	96	102	16
17	96	101	88	88	48												104	99	105	96	116	113	109	94	17
18	102	86		69	63	37	45	53	62	75	94	86	131	107	97	109	105	120	103	96	130	136	116	94	18
19	102	98	67	53	94	80	59	81	81	99	120	128	156	175	199	196	207	193	212	179	190	228	265	236	19
20	232	207	176	132	136	94	79	64		58		78	138	153	147	136	119	157	159	160	149	203	194	185	20
21	171	190	122			84	53	46	59	85	105	116	150	164	182	178	185	174	156	182	200	231	231	201	21
22	166		130	101	96	70	57	52	44			99	100	130	152	139	126	123	135	143	177	178	162	177	22
23	170	141	111	92	85	63	69	56	79	71	79	101	134	152	161	168	144	156	162	153	168	157	198	192	23
24	175	174	140	96	70	78	64	46	52	65	100	102	103	110	134	141	147	156	154	143	170	186	200	217	24
25	175			94	98		55	60	48	67	82	93	124	116	137	146	131	146	116	134	143	148	174	177	25
26	154	151	100	90	92	55	56	42	43	69	66	95	99	119	104	116	147	131	127	148	164	149	137	161	26
27	177	149	133	85	85	62	56	50	53	69	68	113	124	128	155	142	174	144	138	172	168	191	214	177	27
28	175	127	118			53	56	37	42	60	83	85	94	118	132	132	127	116	122	120	120	159	128	150	28
29	121	119	126	94	72	51	65	43	38	61	77	75	105	113	127	123	141	132	106	123	125	135	131	110	29
30	128		95	95	82	64	65	53	72	76	105	112	142	106	116	147	148	147	160	153	172	174	187	194	30
31	160	142	140	100	77	51	62	46	42	49	65	103	122	106	142	116	129	118	126	83	95	168	171	159	31
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...																									
APRIL 1963												CHRISTCHURCH, NEW ZEALAND													
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
01	145			97	85	60	64	63	78	74	96	118	129	131	135	117	157	124	110	121	125	131	141	142	01
02	147	140	84	79	56	52	56	62	54	80	86	117	108	140	124	138	122	142	154	179	176	172	172	173	02
03	158	145	111	84	77	38	44	58	58	59	96	124	134	160	147	144	164	162	154	162	167	186	187	166	03
04	145	123	96	66		49	34	38	33	52	83	96	93	89	106	131	131	124	117	110	157				04
05	181	172	135	107	80	69	50	53	56	91	83	122	115	122	151	145	122	169	174	191	205	236	255	228	05
06	212	193	163	123	86	63	66	69	61	100	106	159	138	162	135	152	142	135	151	164	191	220	259	227	06
07	211	184	113	112	87	71	47	65	69	87	94	120	146	155	177	166	186	150	135	124	195	180	221	200	07
08	206	174		92	77	49	51	56	52	78	94	137	135	155	150	169	166	158	158	173	177	148	90	167	08
09	161	129	95	66	58	63	32	52	39	65	87	100	143	135	130	156	146	125	141	148	136	128	131	151	09
10	140	119	86	86	93	56	62	71	87	75	101	115	130	146	164	168	185	175	200	155	187	217	209	201	10
11	202					52	49	56	73	93	95	115	110	132	122										11
12		122	90	91	54	47	44	53	47	62	93	114	120	126	140	155	123	136	143	175	156	204	187	172	12
13	155	147	125	74	80	51	53	50	56	90	91	113	127	132	131	153	135	116	122	150	155	188	213	168	13
14	164	132	110	93																					14
15			123	96	62	29	60	44	83	94	104	143	154	154	180	163	187	152	116	107	109	221	172	175	15
16	177	157	109	84	67	57	44	34	56	73	94	133	118	117	111	133	112	134	107	106	117	157	148	126	16
17	111	120	89	81	70	47	47	55	47	79	92	110	99	130	128	121	145	125	141	168	196	176	190	158	17
18	168					50	48	40	53	35	86	102	109												18
19	147	115	112	74	62	59	47	53	65	79	121	136	129	113	134	166	159	166	160	153	207	201	240	246	19
20	178	127	104	60	46	44	40	40	64	69	91	91	101	174	178	183	155	166	117	130	150	187	177	150	20
21	155	153	138	99	72	73	57	59	86	90	113	118	105	132	146	156	158	131	115	169	223	217	249	228	21
22	229	174		103	75	80	75	59	78	94	122	142	170	164	147	159	172	183			156	168	155	22	22
23	169	146	122	112	76	60	59	68	71	97	124	156	170	195	161	191	201	164	182	157	189	227	225	198	23
24	197	171	124	110	77	73	59	56	66	81	137	144	159	166	160	181	188	179	180	188	179	244	227	220	24
25	187	183	139		107	79	97	90	103	120	141	168	180	179	189	213	226	274	255	283	303	230	246	199	25
26	176	149	120	88	66	56	62	41	53	83	84	140	140	175	169	151	154	172	148	190	189	218	226	198	26
27	189	163	94	84	60	65	42	66	68	88	106	126	123	162	123	110	139	149	136	152	183	208	201	200	27
28	195	151	112	86	58	54	45	54	52	62	85	114	107	130	138	132	137	149	165	161	176	240	311	253	28
29	238	210		104	81	70	53	57	56	74	113	152	160	129	180	155	164	183	188	158	155	244	285	257	29
30	222	205	143	130	82	83	62	63	71	89	130	159	159	160	162	204	196	173	218	247	242	299	291	257	30

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN..																								MAY 1963												CHRISTCHURCH, NEW ZEALAND																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
HOURS		00		01		02		03		04		05		06		07		08		09		10		11		12		13		14		15		16		17		18		19		20		21		22		23		HOURS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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01	230	213	173	127	83	63	64	57	86	110	122	144	160	165	181	226	219	199	233	222	268	284	299	251	01																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

HOURLY ALL-SKY METEOR RATES
CENTERED ON UNIVERSAL TIMES SHOWN...

CHRISTCHURCH, NEW ZEALAND

JUNE 1963

HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
01	166	99	98	77	44	49	46	58	73	102	109	158	200	236	228	230	249	288	264	270	250	279	228	203	01
02	177	143	114	70	53	44	40	51	52	88	118	153	198	237	242	187	253	271	227	208	208	262	249	183	02
03	139	111	90	72	38	40	40	44	49	99	126	161	211	215	234	195	244	247	268	182	227	185	223	171	03
04	173		104	76	54	40	42	45	65	99	134	171	214	242	270	233	261	273	281	309	272	280	222	236	04
05	185	152	104	95	61	55	50	50	67	85	95	105	139	126	154	150	141	148	156	126	154	201	258	208	05
06	118	122	66	41		47	35	61	66	108	128	173	222	229	248	206	222	236	227	234	210	223	212	205	06
07	157	131	112	58	61	34	59	65	66	105	106	145	166	169	184	170	159	169	183	191	272	241	271	220	07
08	186	129	92	67	51	43	50	61	63	96	120	143	221	240	287	293	260	327	298	340	284	274	281	233	08
09	189	118	99	72	59	41	37	54	59	76	146	156	214	252	258	264	280	303	349	320	330	286	266	241	09
10	187	141		73	49	44	40	48	62	93	143	181	220	235	240	226	233	368	377	359	305	265	226	172	10
11	126	122	86	61	46	41	32	43	69	87	122	177	222	238	292	254	284	289	283	291	260	210	205		11
12		104		55	51	51	35	47	67	81	118	172	214	259	243	236	236	260	284	206	215	222	223	171	12
13	155	108	61	67		40	39	29	65	103	112	164	203	220	234	241	227	261	263	241	244	195	173	171	13
14	111	101	98	54	28	46	35	55	64	96	122	164	196	237	226	250	248	260	267	263	257	236	232	180	14
15	141	100	86	64	55	38	34	25	51	67	101	137	161	188	214	213	224	227	255	231	234	226	166	202	15
16	135	102	83	57	46	47	34	37	56	78	124	138	158	175	163	199	224	259	255	220	219	207	190	190	16
17	137	121		68	41	49	42	54	60	81	111	141	184	237	272	272	281	267	288	239	275	227	214	149	17
18	133	108	75	58	41	35	32	63	68	96	124	133	157	160	171	171	186	176	194	189	240	250	199	175	18
19	130	75	57	53	55	44	40	54	68	80	117	183	191	247	239	223	278	309	305	257	281	266	237	204	19
20	171	136	108			50	49	53	73	111	114	158	189	247	255	300	307	284	318	275	252	250	226	158	20
21	169	104	86	52	49	27	33	37	53	76	118	161	166	211	254	232	211	256	257	195	182	185	171	165	21
22	134	122	71	55	30	43	36	40	58	78	122	162	188	206	253	223	258	222	238	235	228	177	188	152	22
23	127	100	70	53	31	44	34	39	60	71	96	143	162	221	216	222	247	273	264	249	202	176	163	143	23
24	125	107		55	39	19	35	50	57	66	118	161	178	222	218	222	267	290	260	281	214	179	169	141	24
25	115	91	74	53	48	26	34	40	45	77	110	139	183	208	198	261	261	264	252	229	227	166	166	136	25
26	131	106	66	57	48	32	28	38	59	89	101	127	180	195	204	208	232	255	242	224	208	154	143	130	26
27	110	94	65	48		47	37	40	73	87	126	186	204	232	248	287	285	318	318	292	274	234	197	167	27
28	122	106	88	59	61	50	41	46	90	111	129	184	235	260	253	285	336	351	299	298	267	249	198	188	28
29	141	95	75	57	52	40	36	43	67	84	116	150	166	206	239	260	287	284	280	268	225	227	204	161	29
30	138	119	79	67	47	45	38	43	46	81	105	161	176	223	244	238	300	296	286	227	243	185	178	183	30

HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
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HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN..																								JULY 1963																								CHRISTCHURCH, NEW ZEALAND																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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01	127	103		93	54	45	50	42	67	82	139	179	201	259	247	255	348	335	289	272	246	227	184	191	01																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...																								CHRISTCHURCH, NEW ZEALAND											
AUGUST 1963																																			
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS										
DAYS	DAYS																																		
01	80	46	40	39		21	26	35	46	71	116	202	245	297	359	307	309	276	254	239	192	137	121	109	01										
02	92	75	54	34	29	25	21	33	31	73	107	171	234	283	365	353	323	351	266	211	157	131	107	84	02										
03	83	69	34	34	22	15	17	23	41	51	114	137	200	241	280	322	291	272	242	239	135	119	111	106	03										
04	72	73	48	34	24	16	28	25	40	51	91	153	170	255	294	253	288	234	229	184	163	135	125	84	04										
05	80				41	35	31	36	32	64	105	182	191	255	324	318	352	317	305	220	179	172	140	145	05										
06	97	80	75	59	35	32	37	33	46	64	100	111	175	184	245	260	256	240	232	185	148	134	109	94	06										
07	69	69	54	40	25	22	29	28	43	58	87	143	143	226	249	254	212	254	196	198	179	157	142	110	07										
08	127	88	77	55		47			40	63	95	101	133	179	192	227	255	215	212	199	167	164	145	143	08										
09	122	104	80	60	54	49	34	45	44	89	122	160	203	242	273	314	320	310	227	233	231	175	174	127	09										
10	125	93	83	69	65	50	38	34	54	62	97	145	182	246	256	269	286	219	230	165	192	159	142	112	10										
11	91	65	56	54	23	25	20	28	41	62	82	121	159	206	205	252	238	241	191	166	166	126	103	96	11										
12	72	64			44	25	16	35	40	54	89	135	158	178	198	227	206	202	197	202	172	174	146	101	12										
13	85	78	56	46	28	19	33	27	44	49	75	129	168	183	242	224	211	236	192	166	138	149	135	95	13										
14	92	66	65	38	35	31	29	27	26	64	79	101	128	185	204	206	202	217	152	172	139	139	120	97	14										
15		64	46	47		31	34	35	37	48	67	112	125	143	185	237	190	172	172	141	143	149	134	133	15										
16	101	83	58	47	38	26	26	29	30	74	97	131	150	179	135	165	231	203	185	185	167	141	82	89	16										
17	76	74	48	50	22	24	28	27	36	61	77	124	134	203	205	234	232	228	175	174	164	170	147	119	17										
18	98	92	57	49	37	27	22	35	40	53	80	111	165	196	217	250	244	221	220	194	175	161	161	155	18										
19	110	94		57	28	40	37	36	50	57	75	103	130	167	180	187	206	162	163	149	119	133	141	107	19										
20	88	71	49	39	30	32	27	30	41	44	76	98	128	184	183	222	209	180	156	147	122	98	100	102	20										
21	67	51	42	33	26	26	16	25	44	60	86	105	147	162	196	200	200	215	172	144	161	168	113	93	21										
22	78	74	52	36		25	29	32	28	52		91	132	164	192	197	227					127	150	92	22										
23	85	82	48	42	32	21	24	29	36	39	78	106	133	153	197	226	193	192	165	150	163	137	122	95	23										
24	104	76	57	37	37	37	31	27	36	41	78	94	129	193	166	212	214	160	175	189	181	179	151	149	24										
25	119	99	76	56	51	44	36	36	31	55	88	121	154	166	178	222	238	204	173	156	163	150	129	144	25										
26	101	98		49	49	46	36	28	37	72	90	106	159	173	179	196	208	205	193	175	184	153	149	130	26										
27	122	80	71	80	48	52	30	24	39	52	69	108	132	170	172	207	186	200	185	145	137	134	125	126	27										
28	104	91	67	63	52	43	28	35	35	52	75	117	136	166	207	208	206	220	184	193	155	154	156	123	28										
29	107	81	73	47		40	33	49	73	74	91	135	148	188	181	190	216	194	174	177	146		128	110	29										
30	124	94	67	57	48	34	33	37	42	60	82	98	130	154	175	180	201	196	169	152	157	127	137	131	30										
31	91	76	84	57	42	36	32	35	41	59	91	101	133	161	184	199	185	173	184	160	148	149	136	105	31										
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS										

HOURLY ALL-SKY METEOR RATES		SEPTEMBER 1963																								CHRISTCHURCH, NEW ZEALAND	
CENTERED ON UNIVERSAL TIMES SHOWN..																											
HOURS	DAYS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS	DAYS
01	85	77	59	37	46	28	18	26	30	48	61	70	102	141	123	175	162	168	129	130	124	110	120	110	01		
02	93	73		38	22	26	22	32	29	46	52	74	96	109	135	132	144	150	160	134	132	105	108	94	02		
03	66	55	46	27	32	17	22	13	31	37	60	63	85	136	128	141	150	96	120	108	84	78	94	72	03		
04	61	49	41	41	23	23	15	23	25	36	51	63	115	130	130	136	141	122	146	102	110	123	116	74	04		
05	62	45	49	38		25	23	20	32	44	65	95	112	154	134	130	162	160	153	124	165	126	121	104	05		
06	107	74	44	34	32	22	33	27	26	39	65	95	110	144	142	171	171	193	157	148	159	162	137	122	06		
07	94	90	62	42	47	32	31	31	47	47	63	97	107	126	152	186	160	148	154	171		148	115	124	07		
08	106	87	53	28	33	20	22	27	32	40	58	81	119	134	147	154	138	131	150	101	123	118	95	98	08		
09	59	70			55	43	42	48	39	53	67	74	84	110	124	127	157	154	144	130	126	143	145	137	09		
10	106	105	71	53	38	35	25	24	39	36	53	68	82	95	123	134	160	149	155	142	123	138	136	165	10		
11	116	96	73	62	40	37	29	25	34	38	44	74	87	125	133	138	172	165	136	156	165	135	144	115	11		
12	100	77	74	49	31	19	20	20	18	34	59	73	102	140	140	143	159	144	136	136	150	127	129	150	12		
13	100	74	72	45	54	41	48	29	47	51	75	82	146	105	145	180	177	160	143	151	158	161		128	13		
14	122	83		59	63	39	28	48	48	57	63	95		133	155	168	161	193	138	146	155	128	125	130	14		
15	132	76	88	70	69	69	72	55	65	95	113	143	170	194	192	172	167	180	160	186	185	175	144	136	15		
16	109	104		49	55	41	45	41	37	53	62	72	112	138	138	142	174	152	152	122	152	124	92	102	16		
17	87	102	69	49	47	28	43	48	52	81	88	106	130	156	153	175	190	170	140	151	155	152	130	127	17		
18	100	73	65	63	59	46	40	36	53	67	77	98	115	133	139	144	166	138	115	132					18		
19					41	57	52	46	48	57	84	104	106	121	135	165	144	140	153	149	123	121	111	104	19		
20			45			23	11	17	21	36	41	54	77	107	98	96	84	89	93	97	102	92	83	73	20		
21				24	21	21	14	16	22	31	46	69	57	109	106	105	108	99	108	89	78	112	92	67	21		
22	68	48	27	36	27	24	18	24	22	31	43	65	61	101	121	88	110	100	106	98	111	86	103	97	22		
23	73	63	44			59	35	30	46	33	57	68	81	137	123	139	139	127	129	127	138	108	75	95	23		
24	87	75	82	56	38	30	29	41	33	42	70	85	107	121	115	130	134	135	114	116	140	142	141	110	24		
25	119	94	82	68	53	58	33	23	48	60	46	83	106	95	131	110	133	112	122	140	114	155	101	116	25		
26	100	85	69	51				20	27	29	44	63	93	111	143	128	141	131	137	130	152	117	144	119	26		
27	116	110	90	61	28	40	37	33	32	41	52	63	93	100	126	121	112	113	123	113	132	149	130	115	27		
28	110	88	61	47	33	25	19	25	23	31	53	81	88	88	122	150	123	120	110	118	128	170	143	110	28		
29	102						16	17	23	24	29	51	72	58	89	87	104	104	87	107	96	100	95	100	29		
30	104	71		46	37	28	23	9	33	36	50	69	78	83	120	114	109	106	130	112	133	135	106	109	30		
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS		

HOURLY ALL-SKY METEOR RATES
CENTERED ON UNIVERSAL TIMES SHOWN..

CHRISTCHURCH, NEW ZEALAND

OCTOBER 1963

HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
01	87	81	58	33	20	24	16	22	22	39	39	56	73	96	109	115	121	98	104	110	136	110	117	113	01
02	106	104	60	28	23	28	16	20	21	37	41	61	97	107	130	127	108	125	133	132	148			02	
03																								03	
04							17	12	25	17	24	44	50	75	85	77	105	78	81	86	84	82	87	65	04
05	70	41	29	15	17	14	11	10	16	14	32	39	59	64	64	79	68	68	68	71	84	89	69	61	05
06	41	35	28	30	26	29	29	31	36	85	112	119	129	128	120	123	124	110	89	123	121	103	113	142	06
07	76	58	46	30	36	32	26	28	26	46	49	55	67	71	110	86	99	110	100	93	122	103	84	91	07
08		37		21	37	26	20	22	24	32	39	57	35	81	105	86	114	88	97	111	104	118	111	93	08
09	83	54	56	43	26	20	15	16	18	28	54	71	94	123	133	141	156	134	147	151	155	144	117	123	09
10	88	74	62	34	33	29	26	10	18	32	49	66	82	105	131	139	157	137	118	152	149	141	113	95	10
11	79	64	53	40		33	19	47	32	49	79	65	109	129	144	162	142	169	168	167	153	136	123	99	11
12	96	63	58	42	22	25	26	16	18	38	46	71	101	101	167	145	152	164	136	173	190	166	153	95	12
13	84	96	66	46	35	32	29	16	31	42	62	86	100	128	141	176	163	141	176	172	187	171	146	128	13
14	103	87	53	51	40	40	22	32	37	37	58	96	107	145	154	173	149	150	159	166	161	134	145	117	14
15	95	72		38	41	25	27	21	18	35	53	71	92	110	128	100	96	102	108	90	136	137	118	106	15
16	85	62	54	43	25	23	16	22	22	24	21	48	66	99		99	96	81	111	112	119	107	82	16	
17	90	65	60	41	35	23	31	15					57	91	78		144	139	149	145	123	113	94	17	
18	83	81	57	43			15													114	123	99	18		
19	95	70	45	51	34	19	21		23	20	54				117			105	111	126	141	130	94	19	
20	88	70	56	31	33	21	21	30	19							129								113	20
21	85	79	50	33	25										99	121	115	127	107	125	131	141	113	117	21
22	74	77		60	40	42	25	45	34	32	52	88		120	157	140	117	136	168	157	145	144	101		22
23	93	72	72	62	54	38	24	26	29	41	45	82	86	135	145	154	142	117	155	153	153	171	134	120	23
24	105	84	68	49	41	41			39	42	81		85		119	146	120	157			131	136	119	24	
25	113	97	61	55		35	25	27	38		50	50			90	97	84		80	104	109	127	140	115	25
26	102	82	69	48	44	28	32	20			40	51	54	60										26	
27																								27	
28																								28	
29							18	28	40	39	62	73	81	102	119	137	142	133	153	159	181	160	147	122	29
30	94	75			27	35	33	43	33	38	52	75	98	108	139	152	148	152	154	155	172	156	185	139	30
31	105	75	76	48		20	21	19	25	24	45	58	66	76	90	113	92	106	108	120	105	116	123	100	31

CHRISTCHURCH, NEW ZEALAND																							
NOVEMBER 1963												HOURS											
HOURS												HOURS											
DAYS												DAYS											
00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01	72	59	51	48	33	23	26	16	15	46	40	54	74	88	102	103	119	104	107	118	116	116	95
02	89	79	55	44	20	16	21	28	27	31	51	89	67	94	120	127	132	108	137	144	129	146	130
03	85	61	60	54	39	25	26	41	33	40	51	84	76	119	119	115	149	135	141	153	173	143	122
04	108	83	59	41	33	47	47	46	42	65	87	99			139	139			152	183	149	138	116
05	110	123	77	59	53	40	36	35	41		77	100	103	105	132	170	143	161	171	156	159	116	91
06	90	83	78	51	27	34	25	19	22	41	48	56	90	122	117	152	136	156	162	155	191	162	154
07	100	83	61	75		36	34	28	25	49	66	88	104	119	118	165	155	140	161	184	159	167	130
08	95	101	70	59	41	35	42	32	26	49	62	90	103	125	141	154	148	136	160	158	142	170	121
09	119	87	66	70	54	36	36	29	34	32	49	82	99	114	152	141	127	130	125	131	150	168	124
10	113	87		32	32	37	32	30	46	72	87	105	104	136	156	160	155	167	200	172	166	148	128
11	112	94	67	50	24	19	21	35	51	47	78	65	106	130	125	122	142	149	143	156	139	137	107
12	86	82	66	46	21	29	32	28	29	54	87	90	114	129	96	110	113	111	140	141	132	129	108
13	89	75	65	66	50	27	21	28	28	35	47	44	84	102	107	116	110		97	146	116	103	93
14	97	74	76	54	46	30	41	42	43	54	48	76	123	141	173	168	163	162	181	185	203	185	167
15	122	110	82	66	46	38	27	34	29	39	57	83	108	121	124	146		100	122	191	192	195	145
16	97	125	87	68	47	45	26	30	40	41	47	63	78	103	127	137	134	140	145	185	179	156	128
17	88	76	57	41	52	42	39	41	35	37	50	72	89	114	140	132	133	139	148	187	206	179	126
18	119	82	58	56	32	47	32	48	44	45	91	96	108	131	154	151	164	188	184	188	177	155	142
19	138	110	92	79	45	51	27	40	50	47	65	99	117	154	169	199	181	191	212	222	230	192	151
20	123	104	81	79	49	42	36	32	35	49	55	90	99	109	127	136	148	148	174	174	192	144	152
21	110	94	72	76		42	40	28	38	26	43		86				141	172	183	185	168	158	127
22	96	106	71	50	43	48	26	33	18	49		87	95	91	122		50		186	208	183	171	115
23	108	117	81	65	50	45	49	27	35	38	63	86	101	120	141	143	157	152	166	150	191	182	161
24	103	97	82	58	27	27	25	18	45	48	53	77	82	121	132	111	131		101	132	141	128	116
25	101	79		85	73	41	46	37	43	41	70	97	123	146	155	155	133	141	153	156	171	175	143
26	98	104	97	73	76	55	48	46	52	74	76	119	124	163	178	168	164	170	182	229	207	174	140
27	125	98	84	58	58	33	37	29	50	51	61	84	83	121	149	122	130	148	191	206	226	176	128
28	124	96	85	83		61	44	48	50	47	82	95	141	157	169	175	173	134	179	193	171	150	132
29	117	94	58	71	40	53	43	54	45	66	75	87	112	128	142	138	119	140	151	184	214	168	115
30	88	76	73	54	55	37	28	40	45	44	70	79	91	129	125	139	130	85	130	144	169	155	132
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22

CHRISTCHURCH, NEW ZEALAND																									
FEBRUARY 1964																									
HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN..																									
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																								DAYS	
01	131	138	119	106	93	82		45	44	62	67	99	135	146	163	155	170	205	176	191	197	170	173	149	01
02	136	169	137	114	104	76	63	54	55	56	114	111	137	154	172	202	203	172	140	169	189	156	152	136	02
03	137	121		109	87	93	51	66	59	80	85	108	136	162	173	218	224	230	207	199	202	190	172	208	03
04	175	152	157	127	87	83	89	67	65	77	116	134	140	159	171	194	201	205	183	193	177	243	192	169	04
05	143	124	122	109	91	71	63	48	70	90	91	95	100	137	144	178	186	171	189	153	154	191	200	164	05
06	139	163	164	112		64	60	57	55	48		74	119	161	149	197	166	166	175	156	226	166	166	181	06
07	143	190	116	93	87	56	68	53	35	39	59	75	78	106	140	154	144	132	164	179	195	197	180	164	07
08	167	165	121	105	94	70	70	65	61	77	83	131	123	161	155	158	164	156	179	145	185	169	185	175	08
09	154	140	140	108	67	64	60	48	24	26										108	172	228	219	170	09
10	141	134		99	89	66	75	55	39	39	58	62	68	112	165	214	175	167	198	209	226	198	199	224	10
11	199	200	150	144	108	74	68	39	28	38	59	63	103	113	150	132	110	126	143	143	152	182	197	150	11
12	135	160	133	103	73	84	61	31	44	40	53						85			190	230	187	196	171	12
13	183	169	177	108		89	57	58	37	23	29	65	117	128	121	154	170	198	200	217	235	216	228	198	13
14	151	154	119	114	76	82	71	36	45	47	49	45	73	90	90	105	139	122	108	151	162	211	192	186	14
15	181	175	111	98	57	68	43	41	42	58	75	56	83	102	118	143	173	179	145	188	172	192	177	188	15
16	167	146	143	110	75	83	62	66	74	82	104	117	146	159	170	185	174	184	187	214	222	233	191	206	16
17	199	153		112	86	93	63	57	54	72	94	113	105	120	148	139	168	140	167	190	193	208	175	155	17
18	150	136	132	98	71	68	62	53	50	85	91	90	115	137	158	180	179	185	165	151	156	177	163	152	18
19	138	146	133	99	82				55	73	96	95	61	97	82	175	168	141	167	151	177	198	214	182	19
20	167	127	139	128		27	41	38	34	31			64	87	98	80	78	70	73	91	111			89	20
21	103	82	95									31	61	83	57	52	84					125	99	95	21
22	82	87	72	66	47	36	27	24	15	15	41	39	46	41	56	52	60	51	76	64	86	108	133	101	22
23	90	74	78	74	47	37	35	30	27	36	36	44	44			75	80	79	82	87	70	95			23
24							52			32	43	53				78	93	86	60	150	164	114	141	137	24
25	122	117			79																			25	
26	147	129	134	92	75	69	42							56	65	63	59	46	61	78	48	128	151	140	26
27	139	110	101	96			46	57	57	65	74	90	124	122	143	124	141	149	151	144	191	182	153	182	27
28	179	137	131	96	63	60	65	75	70	79	83	112	145	188	168	194	193	191	238	198	241	221	198	218	28
29	197	212	172	130	107	81	69	72	76	91	92	111	119	142	175	167	201	216	224	200	229	236	236	218	29
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN..																								CHRISTCHURCH, NEW ZEALAND											
												MARCH 1964																							
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS									
DAYS																									DAYS										
01	202	186	132	105	101	74	75	69	67	82	109	139	165	177	188	200	159	201	208	195	238	207	215	194	01										
02	169	191		114	81	76	82	65	64	75	96	108	141	160	186	193	152	185	196	176	210	272	224	226	02										
03	196	180	165	133	98	73	69	78	53																03										
04																									04										
05								69	81	67	99	128	125	157	188	213	205	195	192	185	214	186	238	202	05										
06	183	180	140	105	102	83	64	65	79	80	88	129	160	175	156	203	197	201	197	204	190	230	204	223	06										
07	216	183	150	114	73	79	54	60	63	81	104	114	166	158	185	195	163	184	185	194	226	217	204	206	07										
08	208	172	143	131	93	72	62	72	68	74	112	126	145	160	178	180	186	196	184	189	206	205	190	228	08										
09	176	172		99	75	73	49	44	58	59	62	90	103					114	119	144	141	166	139	142	09										
10	132	122	116	97	76	56	57	56	67	56	97	84	89	123	112	131	160	142	52	74	95	140	144	84	10										
11	173	106	136	113	98	69	50	20	49	40	63	115	115	67	85	104	134	113	59	65	87	94	85	125	11										
12	115	103	86	77		55	40	44	46	58	77	75	135	91	88	86	99	85	85	101	122	164	134	121	12										
13	143	148	94	82	70	51	31	20	40	58	65	94	123	111	133	99	112	121	88	113	124	104	101	119	13										
14	99	94	97	70	50	38	36	45	37	50	57	66	65	83	111	99	59	80	87	77	103	100	116	120	14										
15	86	96	82	57	53	53	28	41		59	67	78	78	108	101	102	73	99	94	99	102	107	113	114	15										
16	103			72	59	46	54	42	51	40	53	72	91	99	114	103	92	62	70	59	85	105	83	92	16										
17	109	72	72	61	41	53	29	36	33	39	68	68	83	69			85	80	72	80	74	95	100	86	17										
18	91	79	69	47	34	34	29	23									60	57	83	82	81	81	79	18											
19	60	74	47	43		44	27	26	32	40	60	82	96	85	112	99	115	98	112	101	142	91	120	120	19										
20	99	77	91	55	45	50	34	45	43	59	79	62	67	83	76	72	76	102	68	98	98	96	139	109	20										
21	94	95	69	57	51	40	36	47	43			46		52	61	67	100	90	81	56	81	127	109	133	21										
22	117	119	99	68	50	46	30	32	37	50	61	81	99	97	95	74	107	76	79	90	101	98	115	72	22										
23	113	78		51	32	29	33															184	174	178	23										
24	146	152	101	84	57	46	49	61	61	69	91	109	138	121	143	141	148	161	161	159	161	165	176	134	24										
25	145	119	122	76	63	57	37	54	27	29	54	68	87	90	73			107	116	166	166	173	168	164	25										
26	130	130	78	72		56	54	47	52	68	108	109	131	130	148	170	159	147	143	149	184	195	106	232	26										
27	144	129	127	79	72	54	57	55	66	86		94	125	150	55	135	159	162	109	124	189	169	190	195	27										
28	144	139	106	101	62																				28										
29																									29										
30				86	66	55	39				40			93	134	136	121	146	142	162	157	171	173	138	30										
31	129	126	101	83		49	53	38	40	45	43	78	82	106	111	93	129	104	127	124	152	182	169	186	31										
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS									

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN..																								CHRISTCHURCH, NEW ZEALAND											
APRIL 1964																																			
DAYS																																			
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS										
01	141	128	113	91	58	42	34	24	43	54	69	75	96	102								162	179	170	01										
02	163	130	107	71	52	49	46	40	45	40	52	62	62	56	90	91	119	123	102	113	152	143	162	123	02										
03	135	137	112	73	52		38	34	45	60	98	96	136	118				83	77	76	103	154	186	170	03										
04	141	144	125	72	62	33	28	38	51	66	91														04										
05																						169	164		05										
06	145	114	97	78		28	32	35	30	49	67	67	83	80	88						88	98	115	94	06										
07	78	84	89	36	52	35	43	42	50	47	41	57										78	137	114	07										
08	133	123	98	76	59	32	30	41	49	56	103	81	114	133	140	160	146	139	141	165	158	162	120	154	08										
09	150	106	95		53	56	52	58	53	71	92	110	133	141	139	168	177	134	129	175	168	196	187	164	09										
10	136	120	106	81	65	56	61	57	56	60	94	100	124	114	124	115	105	107	122	124	115	135	172	158	10										
11	162	146	98	64	65	53	39	59	44	54	71	100	113	112	115	123	126	132	148	119	140	214	185	176	11										
12	176	133	90	76	58	44	39	36	46	69	104	106	129	131	134	153	138	182	182	141	164	163	183	171	12										
13	157	114		78	39	40	43	41	58	78	91	96	92	144	129	122	130	128	136	118	156	161	145	160	13										
14	117	160	109	67	57	43	40	45	51	69	103	106	121	125	114	151	116	130	116	140	164	180	165	156	14										
15	139	122	85	73	46	44	39	49	53	74	92	98	139	135	135	129	142	160	150	128	150	170	160	124	15										
16	166	121	85	68			20	26	33	36	46														16										
17							40	44	51	65	73	99	87	125	148	131	136	122	113		124	114	147	135	17										
18	130	126	93	63	48	45	28	48	41	67	53	65	113	132	126	103	100	88	102	102	98	162	168	153	18										
19	142	105	95	55	42	39	46	39	59	64	88	98	111	136	112			119	105	125	144	147	164	186	19										
20				46	35	35	60	43	53	82	109	118	116	143	142	149	155	163	122	117	181	205	195	229	20										
21	167	129	122	90	63	44	54	48	63	92	88	114	143	142	173	153	166	169	147	133	180	228	176	130	21										
22	144	118	89	71	54	41	49	40	56	77	104	123	131	122	106	149	143	155	141	115	178				22										
23						55	36	43	47	68	82	107	138	129	139	145	152	140	131	83	159	165	167	172	23										
24	135	133	76	73	50	53	39	46	61	45	87	95	75	98	102	89	97	93	124	146	183	176	201	185	24										
25	143	123	107	71	51	35	51	40	43	62	86	79	96	133	157	150	121	149	138	123	131	183	175	182	25										
26	128	119	115	72	58	57	39	46	51	80	106	116	115	126	120	139	158	141	161	155	205	182	172	164	26										
27	164	138		69	46	56	49	56	63	71	100	123		112	78						215	197	174	27	27										
28	165	138	100	67	58	43	44	53	76	97	107	138	114	148	138	153	163	153	153	123	137	166	230	164	28										
29	151	182	111	101	58	46	39	55	64	79	92	109	143	164	145	120	127	141	121				143	144	29										
30	130	87	65	57		34	22	30	42	46	73	68	90	102	87	76	98	108	86	124	129	116	123	102	30										
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS										

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN..																								CHRISTCHURCH, NEW ZEALAND											
MAY												1964																							
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS										
DAYS																									DAYS										
01	102	60		38	45	42	25	32	41	52	74	88	84		86	114	98	106	96	119	137	175	172	178	01										
02	102	101	73	56	46	29	35	28	24	52		78	78	84	74	85	103	129	132	160	141	173	192	148	02										
03	138	107	69	43	34	38	30	26						79	69	78	108	97	124	154	146	168	157	148	03										
04	114	89		48	35	39	25	21	29	52	68	83	94	101	94	90	122	125	126	142	154	141	175	111	04										
05	110	86	58	67	41	25	23	28	29	56	79	71	96	93	94	88	100	137	121	155	154	146	146	142	05										
06	141	111	80	57	29	28	21	26	43	45	76	78	88	85	90	96	80	98	127	151	171	132	120	91	06										
07	89						31	27	40	48	82	85	84	57	68	74	82	84	81	121	120	209	190	173	07										
08	99	82	64	52	36	31	31	27	39	55	65	89	109	101	106	118	129	146	123	153	168	182	190	156	08										
09	119	81	69	43	35	30	18	27	35	56	76	80	89	89	103	109	131	130	127	154	159	151	138	140	09										
10	97	81	56	39	33	27	23	33	38	44	67	98	100	97	98	114	104	127	132	142	121	145	129	116	10										
11	93	64		61	62	39	42	51	65	78	87	144	119			118	172	135	134	65	201	212	210	181	11										
12	148	126	118	71	56	42		44	40	81	91	133	121	121	149	112	117	92	96	102	189				12										
13			75	53	45	32	30	32	52	61	69	103	113	116	133	120	136	116	141	137	178	155	172	131	13										
14	123	93	93	53		42	40	43	40	54	75	90	95	99	95	118	97	129	115	119	144	159	152	168	14										
15	144	122	72		38	46	32	37	44	71	78	90	134	117	124	141	138	154	139	151	151	165	177	162	15										
16	172	115	104	60	47	43	42	43	41	71	81	83	101	114	116	118	117	131	138	155	132	185	162	160	16										
17	144	122	101	54	57	43	37	47	45	59	84	104	123	128	109		109	93	116	134	134	117	115	17											
18	126	90				35	44	30	49	65	78	95	136	139	118	122	139	166	138	146	147	121	150	141	18										
19	126	130	81	53	46	37	36	49	54	64	78	102	95	106	101	124	156	164	136	130	111	99	91	97	19										
20	104	77	71	47	37	25	38	30	36	39	79	69	93	104	126	115	133	142	136	122	148	135	117	122	20										
21	78	75	55	50			32	41	48	63	95	107	115	99	97	124	141	134	121	113	136	133	143	149	21										
22	126	122	69	74	40	40	23	47	62	59	87	120	130	140	156	157	135	165	157	127	167	155	168	140	22										
23	122	87	70	47	29	38	32	39	62	66	90	105	134	130	149	124	110	131	134	175	171	151	176	125	23										
24	109	87	79	57	43	35	41	38	51	70	96	88	87	112	95	137	127	120	96	116	169	156	123	122	24										
25	87	67		51	50	38	34	35	61	69	73	95	114	127	140	169	161	182	177	174	155	189		125	25										
26	96	77	65	46	27	25	23	33	37	59	75	108	121	123	126	133	132	154	152	137	142	156	144	126	26										
27	100	87	66	53	47	35	32	45	48	51	66	106	142	121	125	154	125	140	153	130	143	114	117	107	27										
28	98	59	61	53		35	21	31	41	53	68	100	105	119	126	110	117	123	133	132	118	124	116	119	28										
29	93	70	54	38		18	26	31	33	47	64	73	84	84	95	107	105	106	95	99	101	108	108	103	29										
30	87	60	53	43	27	21	21	30	27	45	54	64	65	83	88	87	97	106	62				91	81	30										
31	51	61	44	29	24	15			27	47	62	60	60	77	71	86	77	74	82	64			100	92	31										
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS										

HOURLY ALL-SKY METEOR RATES																								CHRISTCHURCH, NEW ZEALAND																							
CENTERED ON UNIVERSAL TIMES SHOWN...																								JUNE 1964																							
HOURS 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 HOURS																								DAYS																							
1	50	64						21	38	54	62	63	88	71	79	83	89				104	105	102	1																							
2	90	71		53	47	32	29	47	46	77	93	106	175	162	178	167	189	157	187	204	200	195	185	161	2																						
3	124	109	94	58	46	49	53	46	59	77	103	123	156	174	173	173	189	183	176	155	171	179	176	159	3																						
4	134	108	72	58	45	27	38	39	59	66	91	128	136	177	182	181	175	180	240	201	206	225	223	173	4																						
5	132	109					18	28	33	48	80	94	126	116	112	134	128	137	135	117	93	127	137	132	5																						
6	114	77	51	36	24	23	18	33	41	56	76	112	117	147	126	113	122	121	174	152	172	169	172	116	6																						
7	113	77	56	42	33	17	17	31	38	56	84	98	133	157	148	134	128	159	136	123	147		128	109	7																						
8	103	60	47	29	38	37	37	47	49	69	104	141	164	190	214	206	230	243	250	222	210	240	229	164	8																						
9	136	117	77	56	42	34	39	38	50	59	101	144	196	176	201	222	219	244	244	212	232	221	202	165	9																						
10	151	118	82	61	35	38	30	38	50	66	110	154	169	185	226	205	203	248	225	195	217	198	161	188	10																						
11	122	110	80	47			28	41	49	81	99	137	146	196	222	173	191	237	238	239	232	207	201	186	11																						
12	138	107	91	58	45	29	28	31	50	88	100	145	160	223	196	213	221	237	235	236	216	198	174	180	12																						
13	144	100	87	50	51	38	44	36	42	79	92	145	144	157	177	111	105	127	158	147	159	177	205	198	13																						
14	153	126	76	55	34	32	31	38	49	74	110	153	162	198	250	191	222	261	238	182	205	218	177	146	14																						
15	114	103		58	26	31	20	34	54	53	102	135	175	177	169	168	184	185	135			128	109	95	15																						
16	133	103	80	55	41	32	31	25	43	36	92	146	157	154	165	197	161	154	136	142	201	151	82	119	16																						
17	88	52	53		30	33	37	63	65	99	133	135	169			126	150				172	152	141	112	17																						
18	92	63					46	43	55	83	101	132	136	156	173	196	225	252	245	223	206	163	127	158	18																						
19	101	70	70	29	29	23	35	43	66	73	107	135	153	212	206	205	240	226	254	231	182	188	172	143	19																						
20	130	113	72	54	41	32	30	45	52	80	111	145	202	201	185	196	248	279	210	204	203	192	208	140	20																						
21	110	99	70	59	31	20	26	43	45	70	86	154	149	206	239	216	240	280	205	126	152	145	124	107	21																						
22	98	103			41	55	43	41	47	60	118	106	176	178	232	229	241	236	182		240	195	178	127	22																						
23	82	53	52	52	36	23	25	27		66	99	87	128	133	135	119	83	112			197	117	179	97	23																						
24	101	76															121	160	124		184	141	111	102	24																						
25	111	97	82	58			29	25	47	79	105	112	141	159	233	210	125	170	122	113	153	149	99		25																						
26																									26																						
27																									27																						
28																						131	135	119	28																						
29	106			39	44	28	22	27	41	57	92	106	142	131	204	172	182	188	179	171	185	183	133	105	29																						
30	102	66	64	46	41	37	25	32	34	58	80	106	114	166	181	175	194	198	178	173	168	142	134	119	30																						
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS																						

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...																								CHRISTCHURCH, NEW ZEALAND											
JULY 1964																																			
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS									
DAYS																																			
1	87	77	49	42	34	25	20	27	31	52	78	105	130	128	169	198	202	202	212	180	167	154				1									
2		37	44	32	27	18	22	28	35	58	69	93	111	93	122	141	178	151	124	135	143	164	150	113		2									
3	101	67		39	35	36	21	29	44	50	95	123	122	166	191	200	207	186	185	189	171	187	136	152		3									
4	100	81	47	34	28	28	35	22	46	48	87	111	152	185	177	202	221	207	208	172	148	146	139	131		4									
5	106	97	55	45	34	22	27	35	52	80	99	135	141	161	195	230	251	231	209	168	167	150	133	115		5									
6	98	73					12	12	24	22	30	38	51	88	57	102	108	106	109	125	85	77	107	93		6									
7	80	42	49	33	24	19	15	23	25	35	50	77	81	118	114	111	137	111	111	75	92	94	143	105		7									
8	85					19		16	17	19	38	57	61	58	72	79	85	91	79	79	65	85	67	64		8									
9	40	31				14	15	21	32	28	41	52	102	76	88	99	109	95	99	97	101	99	78	62		9									
10	64	62	36	23	18	21	22	19	22	35	40	48	74	85	127	141	142	125	102	123	109	107	108	96		10									
11	69	55	36	21	22	15	16	15	30	27	52	65	92	97	137	93	131	138	108	85	123	82	99	80		11									
12	56	54	40	22	20	15	18	15	23	32	43	74	71	91	114	110	119	120	102	96	67	96	83	66		12									
13	56	44					12			34	39	63	68	68	73	70	99	79	64	59	60	77	56	42		13									
14	42	23	26	12			15	16	17	18	45	44														14									
15						20	21	29	45	66	92	112	141	155	193	183	215	175	131	102	116	95	93	69		15									
16	58	47	29			19	18	13	23	34	50	97	133	157	182	184	205	193	158	132	115	118	117	81		16									
17	56	45				14	21	20	30	40	51	104	106	131	135	155	139	171	120	112	85	92	96	92		17									
18	79	47	48	28	16	15	15	15	24	45	65	81	93	125	143	167	153	145	96	115	92	89	84	74		18									
19	55	28	34	15	21	12	16	23	23	40	67	91	131	146	153	147	170	176	154	133	112	106	91	89		19									
20	68	33	31			22	19	21	27	66	74	122	130	166					180	128	131	121	112	112		20									
21	96	59	47	34	28	28	17	31	34	56	88	105	150	227	261	256	242	267	224	167	171	151	121	108		21									
22	75	60	45	36	38	29	16	36	41	67	80	143	173	221	245	278	243	286	205	143	154	101	116	86		22									
23	58	48				10	13	12	18	33	47	66	98	121	152	172	151	143	148	106	76	69	54	51		23									
24	44	31	24	22	15	18	13			57	68	114	148	158	181	148	160	119	94	93	53	51	53	24		24									
25	36	23	17	18	14	14	7	11	22	33	66	100	126	158	176	185	203	158	129	110	99	56	49	51		25									
26	40	32	25	20	14	14	11	21	20	40	67	96	146	166	164	192	182	162	157	104	101	57	52	40		26									
27	37	32		27	19	23	15	21	48	65	123	198	298	301	340	390	361	283	281	215	180	108	93	67		27									
28	67	55	36	33	31	9	21	24	43	71	131	175	241	338	333	370	367	278	254	193	118	83	61	43		28									
29	65	48	38	21	24	19	13	25	39	67	115	161	194	271	295	289	286	259	222	167	142	81	73	70		29									
30	55	40	27	18			9	15	20	27	67	99	112	154	169	192	182	174	148	124	79			30		30									
31	41	29	26	24	23	21	17	17	28	55	98	161	194	233	267	233	257	264	226	177	123	95	81	59		31									
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS									

CHRISTCHURCH, NEW ZEALAND																									
AUGUST 1964																									
HOURLY ALL-SKY METEOR RATES																									
CENTERED ON UNIVERSAL TIMES SHOWN...																									
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
1	67	45	38	20	20	21	16	17	32	40	73	117	161	209	196	221	245	229	171	150	123	80	104	68	1
2	53	60	41	29	19	20	12	23	29	48	71	112	142	179	192	221	226	192	176	133	92	101	66	66	2
3	62	38								64	85	134	200	199	255	294	312	277	239	195	156	125	115	121	3
4	98	80	72	44	29	26	21	29	26	62	90	147	193	253	259	286	263	250	262	192	169	128	123	123	4
5	92	72	41	37	31	22	25	31	44	58	77	131												101	5
6	82	62	49	43		22	18	20	40	36	74	103	156	209	217	226	250	221	158	142	106	109	92	111	6
7	58	60	50	39	24	31	20	20	21	53	69	107	133	173	203	212	211	198	157	159	131	118	76	74	7
8	52	59	50	47	26	24	23	29	33	58	78	103	139	169	204	230	219	210	162	163	118	100	80	84	8
9	63	57	59	46	29	29	29	26	34	49	64	89	121	163	208	171	233	181	179	155	126	99	103	73	9
10	89	57		31	29	23	23	33	28	55	71	116	133	172	206	183	172	186	202	156	132	111	99	95	10
11	82	60	50	37	35	25	22	16	20	35	69	77	101	151	168	167	175	150	137	113	97	99	94	84	11
12	70	62	46	33	21	24	20	15	32	46	68	90	104	149	152	141	185	188	137	127	120	86	88	12	
13	64	61	47			16	26	13	34	40	63	84	135	145	160	150	170	132	148	143	108	98	79	65	13
14	65	60	40	23	25	23	20	22	30	49	57	88	98	140	148	155	158	139	131	118	115	103	82	89	14
15	68	51	41	30	23	14	22	14	18	49	55	89	110	129	123	179	158	162	158	138	105	104	117	91	15
16	86	73	38	33	22	26						63	125	128	147	138	169	163	141	116	117	89	100	88	16
17	59	54			20	17	21	23	22				101	111	119	142	133	147	108	125	116	90	97	95	17
18	55	63	49	26	21	29	20	20	23	34	54	69	112	99	146	159	154	150	185	131	111	96	66	18	
19	67	57	35	32	20	19	12	26	18	38	52	59	97	104	141	139	141	136	102	116	116	83	94	89	19
20	64	62	40	25	15	27	14	26	21	31	63	56	92	111	104	122	116	116	116	82	89	88	60	20	
21	67	46	37		22	17	20	20	25	36	52	74	84	100	134	140	130	141	120	108	102	83	70	71	21
22	54	58	37	37	12	13	17	17	16	27	40	58	56	87	106	104	103	95	100	88	88	91	90	70	22
23	42	44	40	20	11	12	8	16	29	39	41	57	67	63				93					71	54	23
24	46	32			19	14	16																65		24
25		43	42	28	20	23					30		46	108					86	83	60	72	60	25	25
26	56	51	34	29		15	13			15	31	40	41	89	88	98	103	88	99	74	81	88	54	59	26
27	60	36	45	28		18	13	20	14	25	42	59	96	112	119	134	143	130	114	117	115	107	96	66	27
28	59	58	34	31	28	23	21	15	27	29	42	77	106	111	120	127	126	115	129	105	100	117	98	76	28
29	77	52	41	29	23	24	23	20	23			74	106	84	118	131	131	113	105	103	88	85	97	89	29
30	63	53	35	32	18	16	32	20	14	31	33	35			90	127	94	91	85	100	108	106	70	87	30
31	74	56																							31
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...																								CHRISTCHURCH, NEW ZEALAND											
SEPTEMBER 1964																																			
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS										
DAYS													DAYS																						
1																									1										
2																									2										
3						19	19	17	18	39	65	79	101	117	114	111	132	117	123	124	89	85	93	78	3										
4	66	62	48	38	23	17	28	23	18	23	50	77	84	123	139	149	146	131	116	113	108	99	96	93	4										
5	79	61	48	44	28	20	17	16	23	29	46	73	86	116	137	150	126	134	122	103	104	124	108	93	5										
6	68	56	56	33	36	27	23	26	27	31	47	72	101	120	126	133	132	91	92		86	115	115	90	6										
7	60	61			14	18	15	24	26																7										
8																									8										
9																									9										
10						13	20	14	19	33	51	53	70	98	97	104	70	78	83	83	92	77	79	64	10										
11	54	36	35			15	14	9	21	20	38	43	65	66	82	97	84	88	94	79	91	73	58	57	11										
12	47	43	31	24	22	16	17	16	20	21	40	45	71	79	94	110	90	89	68	77	51	79	63	71	12										
13	55	38	32	15	25	14	18	10	17	26	35	48	53	80	96	76	96	85	71	79	76	79	78	49	13										
14	38	36		45	29	25	20	23	31	37	56	69	89	101	99			136	109	121	121	110	121	137	14										
15	84	77	53	44	22	22	18				31	52	53			65	83	100	79		112	107	104	15											
16	85	87	52	38	34	19	26						105	130	124	126	131	120	111	135	122	145	125	114	16										
17	98	61	54	38		21	25	26	32	35	55	79	96	120	131	155	137	147	133	142	133	145	146	98	17										
18	97	82	58	46	34	32	27	27	35	39	53	93	95	128	132	147	142	130	126	121	128	137	121	95	18										
19	83	82	58	32	43	25	16	26	14	36	50	74	100	107	112	123	109	117	102	119	122	109	101	94	19										
20	92	59	55	54	24	22	20	30	33	31	56	78	72	113	118	136	120	120	125	102	119	127		20											
21	80	74		37	21	24																		21											
22																								22											
23																								23											
24						14	16	25	28	31	36	72	76	88	103	114	99	80	121	95	97	105	95	96	24										
25	71	77	45	35	30	24	21	20	14	29	49	74	71	92			73	81	88	88	131	104	97	109	25										
26	66	68	56	34	34	21	13	15	16	26	36	68	86				122		75	104	106	126	115	95	26										
27	74	83	43	28															121	117	130	117	92	27											
28	78	76		52	26	22	13	18	27	29	37	59	69	93	112	92	108	107	91	106	139	127	115	111	28										
29	97	62	53	34	22	20	20	26	20	19	34	65	87	102	109	126	122	96	114	115	152	152	106	122	29										
30	80	76	64	45	25	33	23	16	26	33	41	67	91	125	114	120	104	102	116	118	131	132	139	119	30										
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS										

HOURLY ALL-SKY METEOR RATES													CHRISTCHURCH, NEW ZEALAND													
CENTERED ON UNIVERSAL TIMES SHOWN...													NOVEMBER 1964													
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS	
DAYS.													DAYS													
1	61	64		35	36	18	10	21	15	22	47	49	78	72	92	102	96	91	97	93	97	108	83	78	1	
2	86	67	65	47	39	34	26	22	17	38	60	63	76	117	97	101	138	110	130	99	113	119	100	82	2	
3	59	61		40	36	21	18	24	27	30	44	62	67	90	98	104	106	101	97	106	121	119	97	82	3	
4	67	67	45	51	29	26	14	14	25	32	42	54	62	94	110	101	99	94	77	101	112	106	94	83	4	
5	75	44	55	38	35	28	17	21	25	38	41	57	76	82	92	98	101	90	98	104	109	82	100	84	5	
6	79	60	58	45	29	20	16	29	29	39	26	48	72	75	120	118	136	87	118	145	130	141	126	70	6	
7	74	46	72	54	56	14	27	20	39	29	47	58	72	107	102	98	91	85	89	112	105	116	82	89	7	
8	79	70	66	54	29	33	31	26	36	35	27	54	83	85	84	126	114	93	78	83	132	128		66	8	
9	87	85	54	50	18	26	27	27	28	31	25	46	70	82	102	89	68	85	78	118	103	100	78	77	9	
10	60	64	44		26	19	19	23	12	32	37	53	70	56	88	77	84	83	100	126	122	130	100	91	10	
11	47	57	61		17	26	29	27	24	31	50	66	72	85	76	105	91	88	125	131	107	108	97	104	11	
12	74	71	64	47		28	18	30	28	31	49	71	79	88	89	94	78	113	112	133	140	128	98	97	12	
13	69	72	58	56	41	33	23	28	18	34	41	70	69	90	81	80	84	104	94	114	132	139	110	103	13	
14	79	72	51	58	43	25	16	19	20	36	36	63	87	83	92	108	94	109	117	135	115	120	82	91	14	
15	73	63	59	30	38	33	30	24	30	43	52	60	82	73	100	93	91	110	97	144	150	109	104	81	15	
16	76	75		51	27	22	24	23	21				50		117	87	89	76	110	113	127	116	96	95	16	
17	71	66	70	36	46	29	29	31	21	32	42	64	76	94	116	96	104	105	111	143	118	119	101	76	17	
18	69	65	62	47	43	34	21	14	25	46	49		71	89	92	80	99	101	104	110	116	125	109	81	18	
19	75	61	64	54			28	25	23	45	33	90	88											19	19	
20	70	58	61	44	43	23	31	27	30	37	57	70	74	74	120	103	106	98	95	104	132	141	134		20	
21																									21	
22																									71	22
23	65	51			18	22	19	26				68	70	98	111	121	111	92	109	127	161	128	114	126	23	
24	71	86	70	60	45	38	22	30	31	40	37									97			95	90	24	
25	82	66	62	54	41	33	33	25	40	39	47	65	68	86	94	102	111	102	98	141	103	123	97	81	25	
26	56	57	47	46			29	17	20	37	34	59	79	105	125	108	96	97	91	110	116	112	91	76	26	
27	55	52	53	40	29	32	23	24	26	33	45	56	71	88	97	91			91	105	101	123	92	92	27	
28	78	59	69	55	34	27	20	24	25	31	46	58	76	88	95	106	94	72	108	122	104	98	85	88	28	
29	70	57	47	43	49	27	35	25	36			57	58	90	101	115	98	90	97	115	126	119	112	73	29	
30	59	60			44	50	25	19	35	39							70	77	124	136	146	139	124	80	30	
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS	

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...		DECEMBER 1964												CHRISTCHURCH, NEW ZEALAND											
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
1	94	63	70	47	35															145	149	113	89	93	1
2	71	76	58	41	39													90	118	115	101	116	92	75	2
3										37	52	46	79	83	93	82	79	69	102	109	92	108	85	71	3
4	94	80		53	46	40	34	36	51	43	64	78	101	130	129	129	114	132	134	154	170	155	115	100	4
5	89	73	72	60	53	44	27	37	40	34	56	74			155	160	127	130	153	188	166	155	146	93	5
6	90	94	72	66	40	29	37	30	41	53	74	77	115	140	134	162	115	114	160	143	137	137	135	133	6
7	100	93	84	71	37	38	34	19	47	38	73	86	104	113	132	152	139	125	172	143	149	137	139	102	7
8	99	81		50	38	31	34	34	34	43	45	62	74	81	74	93	75	86	113	99	133	114	108	92	8
9	87	74	54	54	41	36	33	25	35	47	37	57	69	101	110	128	104	104	119	129	133	119	90	88	9
10	65	80	63	40		40	34	31	46	51	60	56	85	95	103	74	87	100	110	148	127	139	117	110	10
11	86	77	79	59	38	52	29	23	35	47	56	60			125	133	111	136	150	144	124	151	103	112	11
12	88	84	75	64	41	44	39	30				51	75	74	114	85	106	114	110	146	116	120	114	109	12
13	82	110	61	54	35	35	26	30				64	77	88	96	129	109	102	104	99	111	120	119	107	13
14	79	88		52	44	23	29	40	33	47	56	72	86	106	112	113	104	122	120	138	118	120	111	96	14
15	85	75	91	55	30	40	43	30	37	33	53	81	77	108	124	105	112	109	123	111	116	118	125	103	15
16	78	93		59	54	31	57	40	42	56	62	87	94	96	118	120	145	138	151	154	142	145	90	108	16
17	101	90	87	81	43	46	38	49	33	47	66	76	114	117	124	120	134	124	145	139	141	138	128	97	17
18	107	91		82	53	46	31	33	36	48	56	63	74	115	99	121	150	158	152	168	155	143	117	137	18
19	106	115	82	73	60	41	33	37	41	34	43	72	69	81	70	81			147	144	144	128	157	128	19
20	101	71	61	69	60	55	34	30	38	40		66												140	20
21	101	112	76	85	68	56	44	52	49	50	68	81	93	126	128	134	142	147	170	174	166	168	145	162	21
22	135	94	78	59		50	38	43	58	53	71	108	105	139	131	132	147	186	174	179	201	184	175	171	22
23	154					59	45	52	59	50	75	90	114	132	164	160	187	201	212	222	193	205	187	141	23
24	142	127	103	79	66	54	48	43	38	71	80	92	134	153	162	182	177	216	212	243	194	250	182	128	24
25	124	116	109	92	60	40	54	42	48	59	67	99	136	138	152	148	157	181	191	191	214	195	182	187	25
26	131	117	99	72		41	47	35	46	64	68	104	123	125	160	145	136	162	174	203	198	172	139	128	26
27	100	97	91	61	46	43	47	40	45	64	87	102	136	144	129	124	157	191	181	186	186	179	148	134	27
28	130	124	72	61	71	44	42	53	39	51	72	113	98	144	136	131	124	161	159	200	196	188	174	139	28
29	122	97	116			57	43	49	62	69	84	97	139	164	164	157	187	194	230	197	192	210	188	130	29
30	121	104	90		59	57	36	40	34	45	56	77	116	122	133	136	144	149	175	192	213	168	135	124	30
31	115	96	85	83	65	48	36	43	51	65	64	83	110	153	147	140	127	141	150	205	213	166	136	136	31
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...										JANUARY 1965										CHRISTCHURCH, NEW ZEALAND									
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS				
DAYS	DAYS																												
1	115	135	93	88	73	62	43	41	58	61	87	83	104	123	135	148	155	156	172	170	178	164	173	163	1				
2	122	114	86	99	69	49	39	35	50	47	73	114	120	119	160	173	141	188	159	173	200	160	157	144	2				
3	133	121	86	94	80	42	46	34	41	52	56	74	88	100	110	105	109	118	104	133	137	149	134	93	3				
4	90	78	84	61	58	47	30	24	43	52						92	120	154	156	144	137	141	109	4					
5	95	89	80	73	80	47	42	51	43	57							91				150	133	112	5					
6	102	77	83	85	71	47	50	42	36	66	71	101	117	127	127	120	146			116	101		95	6					
7	116	100	88	70		66	31	29	49	47	58	69	97	148	175	148	140	159	180	191	200	210	144	157	7				
8	146	134	111	95	103	67	71	54	42	33	74	101	118	136	135	165	141	160	150	204	171	203	184	166	8				
9	143	124	130	114	82	66	61	32	36	37	67	47	116	101	108	118	113	121	165	194	201	196	189	180	9				
10	124	151	127	131	95	71	63	58	56	49	64	77	127	143	136	138	157	134	202	191	216	173	181	195	10				
11	154	138	140	120		62	63	69	55	41	53			80	114	125	104	106	105	126	163	163	168	176	11				
12	139	143	126	120	94	102	52	55	46	42	58	83	92	122	118	120	152	168	121	116	196	183	206	155	12				
13	140	141	139	114	105	77	69	68	56	88	96	116	121	168	159	168	175	204	194	209	246	225	193	141	13				
14		129	149	149	100	82	80	69	57	77	85	100	122	164	157	159	168	192	188					166	14				
15	124	139	136	99		55	55	60	46	61	79	93	94	101	100	97	127	131	132	102	121	123	127	105	15				
16	81	71	80	64	67	41	60	34	39	46	58	78	81	104	87	104	101	91	81	102	127	106		16					
17		97	99	78	77	45	38	44	40	45	58	55	105	94	95	140	154	147	161	158	146	152	140	129	17				
18	127	141	125	100	77	69	64	77	60	74	83	112	103	153	165	147	139	149	161	149	160	153	156	132	18				
19	120	101	137	101		75	80	59									90	136	119	127	143	135	132	122	19				
20	98	111	78	61	39	41	64	54						86	104			93	73	106	143	144	132	103	20				
21	91	92				54	65	66	59	75	124	149	122	163	146	140	126	167	154	164	172	142	150	21					
22	122	128	119	118	71	77	69	56	73	76	66	97	120	148	123	170	154	138	153	152	138	131	144	119	22				
23	113	126	111		62	74	84	60	57	72	86	84	112	104	118	137	120	140	156	138	124	153	147	137	23				
24	140	115	104	97	63	49	38	41	47	61	71	80	110	126	144	155	134	167	102			151	132	24					
25	161	120	115	96	80	73	53	63	69	64	73	92	114	141	157	151	132	125	139	152	160	141	139	128	25				
26	120	110	120	88	90	69	52	46	51	63	81	100	121	124	137	137	152	148	139	147	150	149	133	139	26				
27	120	111	102	99		59	54	33	42	48	64	81	86	92	83	98	101		91	103	112	104	108		27				
28	82	71	65	47	55	65	51	46	66	68	74	82	106	127	162	143	136	109	151	153	139	143	127	124	28				
29	139	147	118	95	79	65	48	47	54	61	85	101	115	121	129	128	135	145	131	137	136	137	126	137	29				
30	127	134	131	114		81	53	51	53	63	84	90	134	130	151	155	154	132	139	164	141	145	152	146	30				
31	146	108	113	90	78	78	58	63	53	76	93	103	121	146	164	148	148	146	137	134	148	154	157	151	31				
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS				

CHRISTCHURCH, NEW ZEALAND																									
HOURS ALL-SKY METEOR RATES																									
CENTERED ON UNIVERSAL TIMES SHOWN...																									
FEBRUARY 1965												HOURS													
DAYS												DAYS													
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1	136	119	136	134	94	74	57	51	75	52	85	119	145	159	156	152	160	145	138	145	152	126	165	145	1
2	145	137	122	103	92	63	65	60	51	51	76	90	105	146	134	150	125	142	119	145	151	132	132	133	2
3	123	122	103	118		72	68	63	62	60	78	83	119	119	125	103	129	121	118	97	109	127	131	122	3
4	107		70	61	80	67	79	52	87	80	103	126	121	142	154	152	125	161	162	134	137	161	153	4	
5	149	137	129	125		90	86	78	62	78	99	105	122	98	145	162	156	125	122	125	148	145	165	133	5
6	141	134	132	94	99	81	68	69	73	76	91	112	141	138	145	169	152	123	127	139	116		122	6	
7	131	118	110	126	82	68	67	65	46	68												120	143	7	
8	154	118	87	99	81	72	52	58	52	52	81	80	99	106	117	133	128	119	128	143	149	170	151	164	8
9	123	102	90	106		52	77	50							101					109	110	134	120	115	9
10	98	111	104	106	83	64	42	41	39									112	155	140	128	155	130	144	10
11	123	120	123	109		55	68	31	63	56	67	89	83	112	107		129	104	101	125	130	121	109	115	11
12	109	112	93	92	91	53	47	62	49	60	74	75	109	110	132	163	140	153	126	133	151	137	99	120	12
13	146	118	120	90	62	48	60	42	44	58	77	93	103	122	146	153	157	149	164	150	114	140	146	141	13
14	127	130	113	95	81	74	53	67	51	62	82	97	114			115	131	129	120	148	181	171	153	166	14
15	148	132	103		59	59	45	31	53	62	68	106	114	115	156	132	121	121	130	142	151	146	132	137	15
16	134	115	103	105	73	73	58	58	60								141	147	136	165	156	168	134	107	16
17	138	138	115	83	75	44	62	41	54											172	189	163	147	17	
18	120	96		112	90	76	82	75	66	74														18	
19	127	123	116	128	92	72	61	65	57		64	114	85	121	136	148	137	137	140	152	140	128	137	125	19
20	138	124	108	96	68	65	59	56	64	67	60	92	115		124	129	127	133	119	150	139	144	177	163	20
21	126	135	106	76	61	59	54	52	45	70	70				97	123	123	131	107	126	166	155	166	127	21
22	147	141		93	81	69	54	84	70	62	99	105	99	122	129	138	114	90	114	118	130	169	162	147	22
23	141	147	116	91	79	68																153	143	23	
24	154	143	120	95	99	55	58	65	47	68	67	93	90	114	129	153	164	137	161	171	146	144	138	142	24
25	147	127		82	70	76	51	52	53	57	69	92	114	119	167	123	144	153	172	161	162	168	157	148	25
26	132	136	116	96	88	77	74	62	55	66	87	96	134	140	125	159	124	155	135	133	163	152	143	120	26
27	168	117	103	87	79	69	64	67	42	66	96	103	98	140	151	155	178	150	150	171	169	120	159	126	27
28	121	143	117	77	80	61	53				81							65	140	172	142	147	127	109	28
HOURS												HOURS													
00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...																								CHRISTCHURCH, NEW ZEALAND											
MARCH 1965																																			
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS									
DAYS																										DAYS									
1	129			84	55	49	37	39	49	41	67	92	116	138	157	133	125	106	108	108	139	138	136	115	1										
2				88	61	51	42	46	51	58				128	126	117	129	107	98	89	100	118	97	2											
3	106	94	100	87	70	40	30	56	47	47	62	73	108	111	138	142	140	126	118	124	119	124	155	161	3										
4	120	121			85	57	32	52	43	40	59	77	84	102	115	118	118	106	87	101	113	140	144	135	4										
5	114	138	114	59	74	51	43	37	59	58	79	95	105	114	146	138	116	127	126	134	144	142	164	161	5										
6	132	139	122	102	46	36	43	48	55	71	78	89	113	90											6										
7																									7										
8	106	98			65	58	53	49	53													138	117	8											
9		128	100	80	62	54	45	31	54	74	81	112	93	115	151	149	153	134	143	154	145	148	143	180	9										
10	150	129	111												111	153	128					185	178	163	10										
11	132	140		87	68	64	41															101	76	11											
12	126	141	142	89	68	48	42	30				102	87	106				97	95	133	137	131	153	120	12										
13	154	124	142	106	88	78	48	45	61	77	86	115	121	120	139	129	121	108	115	104	101	133	124	103	13										
14	140	136	110	95	76	42	45	54	41	50	69	82	101	138	112	132	133	125	113	134	158	138	153	153	14										
15	150	143		126	64	54	47	54	50	48	66	79	100	121	112	118	136	140	145	126	156		152	87	15										
16		139	112	91	85	57	55	53	58	60	87	89	114	134	143	142	136	153	137	151	159	140	139	137	16										
17	138	101	106	78	58	46	43	60	68	73	86	108	118	130	127	153	156	143	142	153	168	138	166	183	17										
18	125	126		119	79	70	46	53	60	71	90	95	107	99	127	127	118	123	111	118	114	127	143	124	18										
19	121	141	110	76	86	59	55	67	53	72	84	77	92	111	122	129	124	103	104	100	112	130	128	119	19										
20	135	120	105	71	88	57	42	62	68	65	91	96	112	122	129	118	110	121	117	123	131	123	154	160	20										
21	121	136	100	100	68	45	49	37	61	67	78	87	142	91	100	111	120	113	124	125	124	140	138	155	21										
22	123	123		77	66	49	69	53	64	78	75	101	111	109	112	130	108	114	122	126	108	132	109	127	22										
23	119	132	97	95	73	55	51	42	92	78	78	97	99	103	110	117	95	91	108	115	119	139	121	123	23										
24	121	139	98	75	68	49	52	49	55	50	83	97	120	111	105	131	110	118	94	107	97	146	135	109	24										
25	123	108			59	61	38	55	65	74	90	97									151	167	178	148	25										
26					67	53	43	46	50	78	87	104	129	119	169	136	137	143	147	144	170	148	169	169	26										
27		120	92	48	55	48	40	52	47	65	73	87	120	129	130	141	153	155	126	142	145	171	175	194	27										
28	158	111	91	89	52	58	55	41	55	58	89	90	115	136	134	137	127	115	117	133	122	173	138	136	28										
29	150			84	55	52	47	39	49	50	74	75	85	90	124	99	123	104	125	123	130	130	130	158	29										
30	158	138	119	94	64	37	50	40	48	72	97	110	105	103	95						106	130	124	140	30										
31	127	142	123	84	72	68	61	76		76	94	106	119	103	119	112	100	94	87	102	126	151	187	182	31										
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS									

HOURLY ALL-SKY METEOR RATES												CHRISTCHURCH, NEW ZEALAND													
CENTERED ON UNIVERSAL TIMES SHOWN...												APRIL 1965													
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
1	155	136		78	68	52	50	61	64	67	83	84										117	172	150	1
2	153	141	118	92	75	69	68	71	59	77	87	116	114	99	125	115	96	106	126	126	149	166	160	183	2
3	164	156	105	91	78	72	61	54	73	74	99	109	117	124	110	114	131	109	94	120	125	157	169	166	3
4	169	151	142	98	74	77	62	76	62													159	166	4	
5	157	129		85	53	60	50	53	49	70	70	112	108	108	96	129	106	103	115	121	110	161	174	182	5
6	146	119	100	85	80	53	59	57	53	88	99	102	116	130								136	143	6	
7	157	159	112	84	67	63	49	53	66	86	81	111	134	158	134	118	143	154	128	161	127	162	172	174	7
8	127	136		95	54	47	38	42	69	80	87	118	102	135	133	132	144	106	99	124	150	158	162	154	8
9	139	128	125	74	53	47	50	48	45	72	62	88	116	127	151	139	158	150	144	154	170	159	182	174	9
10	173	122	115	94	71	58	55	62	70	89	78	118	127	128	147	123	144	133	118	145	156	171	167	190	10
11	167	151	116	77	66	64	54	56	54	74	97	88	114	113	130	133	132	117	109	130	125	154	138	132	11
12	130	127		67	68	45	44	39	55	60	83	88	120	106	105	130	121	121	109	108	146	132	113	146	12
13	133	94	78	64	65	41	34	39	57	57	82	92	103	112	111	99	110	121	117	123	130	129	167	182	13
14	145	126	89	84	59	49	46	58	52	62	92	113	106	122	117	94	126	106	75	91	135	157	162	129	14
15	143	138			75	74	69	70	66	76	113	93	134	123	120	132	108	159	113	126	156	165	185	216	15
16	173	147	129	106	84	59	53	53	55	101	96	122	118	114	120	109	121	113	125	142	160	173	220	183	16
17	187		110	93	71	59	51	62	72	104	123	140	148	152	162	131	153	144	150	153	179	192	230	213	17
18	200	161	118	104	67	49	51	50	56	108	98	136	143	165	132	118	149	143	128	160	177		144	124	18
19	118	91	81		51	40	38	30	43	57	79	104	87	98	122	126	109	112	124	98	135	116	161	153	19
20	139	98	87	65	65	37	41	49	71	64	102	114	137	136	154	161	175	158	168	195	214	199	182	164	20
21	166	118	101	84	53	50	41	42	61	69	75	91	133	113	147	130	150	173	160	172	172	195	213	169	21
22	165	131			74	52	58	53	69	81	126	136	137	150	160	156	159	180	157	198	210	240	226	187	22
23	172	135	103	76	65	53	50	56	66	77	96	122	147	142	156	183	226	196	190	180	187	195	256	236	23
24	195			82	78	46	43	39	50	63	84	114	146	112	148	161	196	150	150	188	188	216	186	183	24
25	172	141	112	81	59	57	52	43	48	66	89	122	125	120	133	133	172	188	201	227	223	193	228	264	25
26	181	162		57	58	55	71																	26	
27																								27	
28																								28	
29							37	33	47	59	75	78	96	102	103	119	124	118	118	103	112	123	142	155	29
30	141	142	92	68	61	42	48	48	37	67	78	100	95	110	108	124	102	125	114	122	152	171	199	204	30
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...																								CHRISTCHURCH, NEW ZEALAND									
												MAY 1965																					
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS							
DAYS		DAYS																															
1	134	121	93	80	64	37	39	42	50	68	83	92	87	90	96	104				109	93	137	141	161	147	1							
2	104	105	91	46	49	31	37	26	49	43	78							93	87	108	135	131	163	220	2								
3	150	137		67	50	36	50	47	69	91	96	131	145	149	143	166	187	209	207	204	259	261	255	231	3								
4	194	143	100	69	65	53	42	51	60	94	99	125	136	146	160	158	198	214	226	275	252	256	233	197	4								
5					44																	276	244	5									
6	184	133		106	70	50	54	69	65	83	97	137	127	142	141	147	151	144	191	217	230	305	249	237	6								
7	180	140	118	83	63	62	51	65	61	77	105	138	130	144	151	128	172	192	183	219	239	249	251	244	7								
8	183	149	112	95	58	49	56	53	64	72	112	110	126	143	150	145	130	167	161	188	244	225	252	214	8								
9	187	159	94	78	52	46	50	47	70	77	100	110	100	144	122	141	135	165	176	174	199	195	193	174	9								
10	149	119		77	50	51	42	36	53	62	70	74	92	78	91	100	108	95	132	124	146	158	162	129	10								
11	131	95	100	71	45	42	33	37	50	60	71	89	104	111	93	113	87	113	111	146	176	168	171	128	11								
12	122	97	80	63	49	47	36	46	40	74	80	107	103	103	115	123	113	133	158	153	168	167	143	171	12								
13	154	107	97	72	62	39	35	51	66	66	94	108	98	116	120	104	131	127	143	142	184	185	173	166	13								
14	144	107		55	57	45	37	71	61	74	94	140	141	149	182	182	181	188	210	206	236	227	224	199	14								
15	194	156	98	84	58	46	54	54	63	88	104	133	139	167	170	172	216	193	210	202	217	204	196	190	15								
16	160	127	115	77	59		40	52	53	91	134	142	116	172	158	195	168	178	182	157	210	214	181	175	16								
17	160	120	100	62	65	30	54	39	62	65	87	123	139	155	175	171	177	203	170	194	219	218	205		17								
18	147	103	73	67	48	22	43	49	63	87	102	129	119	115	159	149	159	161	163	160	175	173	174	170	18								
19	152	123	100	67	60	40	43	45	56	81	88	97	120	119	126	138	126	153	171	172	171	163	157	157	19								
20		115	92	56	60	49	30	44	54	76	93	112	127	131	153	152	133	138	175	168	154	181	177	183	20								
21	155	119	91	59	60	57	37	50	68	72	119	136	137	144	174	140	185	186	206	186	222	166	222	185	21								
22			103	74	69	51	59	63	78	87	117	141	157	176	159	184	186	188	214	229	199	224	212	195	22								
23	177	147	101	62	64		46	59	71	93	132	147	149	178	155	177	180	175	178	211	231	196	181	185	23								
24	141	123			64	62	64	49	72	111	114	154	177	157	162	169	178	211	189	173	196	214	183	164	24								
25	132	104	93	57	49	39	42	44	78	103	108	143	162	179	152	171	197	221	197	181	198	165	162	192	25								
26	136	135		58	46	44	42	51	64	71	107	139	149	164	144	169	174	186	185	168	192	185	198	127	26								
27	129	98		69	47	37	44	51	73	106	120	138	164	142	129	143	147	155	182	195	198	220	226	174	27								
28	160	122	91	63	45	44	39	53	52	96	104	144	169	190	173	234	194	244	222	214	219	212	203	165	28								
29	143	107	76	58	61	70	54	64	75	105	132	118	156	122	134	139	177	225	202	216	225	202	173	149	29								
30	167	114	104	83	66	37	40	53	58	93	100	135	146	177	169	203	177	213	226	187	178	152	144	147	30								
31	110	75		64	49	39	41	63	61	92	140	169	162	183	182	215	228	278	239	257	259	256	192	175	31								
HOURS		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS							

HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...																									
JUNE 1965												CHRISTCHURCH, NEW ZEALAND													
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
1	133	135	88	81	56	47	45	45	63	91	123	162	194	175	173	184	205	230	213	207	230	207	202	183	1
2	142	134	62	69	49	27	43	44	54	82	119	141	165	181	243	244	224	238	198	265	237	232	191	158	2
3	157	125	85	67	64	55	40	46	61	99	133	159	188	197	207	188	230	258	274	268	247	256	248	197	3
4	153			48	46	49	48	49	85	85	104	125	153	160	157	163	190	216	232	231	235	244	230	199	4
5	174	107	97	67	49	34	31	35	45	80	99	143	149	176	177	173	194	227	256	250	259	233	238	198	5
6	171	116	69	55	53	35	44	48	68	75	109	122	164	156	159	171	208	213	210	237	221	238	214	187	6
7	178	128	93	65	49	49	39	43	55	85	115	107	163	204	170	202	191	273	248	271	202	206	186	173	7
8	160	126		42	39	41	52	49	64	85	111	141	130	171	137	135	170	201	205	207	217	208	230	198	8
9	169	105	80	44	46	47	34	52	54	56	115	136	182	192	184	159	174	254	223	241	215	222	213	174	9
10	151	112	66	54	43	36	34	33	63	84	112	162	186	241	252	193	216	270	286	251	259	199	221	167	10
11	143	111		53	46	42	45	42	76	87	134	148	186	233	219	216	232	297	257	251	261	251	241	200	11
12	183	124	96	70	51	41	37	45	55	73	89	135	153	188	185	193	193	208	230	234	223	230	249	203	12
13	170					55	49	51	70	80	107	107	162	154	153	158	174	201	209	226	221	251	201	193	13
14	144	102	71	59	44	45	40	50	53	75	123	128	177	195	177	183	199	226	206	211	236	212	203	179	14
15	126	98		60	48	60	39	47	72	70	110	140	164	204	189	180	193	229	231	225	235	216	214	162	15
16	107	98	79	54	60	43	36	60	53	66	104	127	147	187	170	179	230	253	266	257	240	204	180	174	16
17	129	108	88	78	55	45	45	52	66	76	98	120	163	158	177	175	182	217	220	226	242	184	185	176	17
18	166	88		70	59	29	49	42	67	78	113	138	155	217	204	204	218	228	241	199	226	235	210	190	18
19	129	116	73	64	50	39	44	47	57	77	115	149	190	209	217	194	252	269	251	232	249	235	203	159	19
20	146	117	77	61	55	36	42	37	79	92	132	134	199	195	231	232	254	255	238	248	204	173	197	156	20
21	134	116	87	69	53	54	38	45	52	68	105	138	167	200	224	252	258	235	254	238	208	204	160	169	21
22	145	82		49	41	43	36	48	69	88	95	135	150	179	191	180	169	183	212	192	196	169	110	158	22
23	118	89	62	57	37	28	33	34	48	62	83	131	171	175	156	176	194	184	188	166	153	159	136	124	23
24	106	77	51	47	43	24	42	42	58	61	96	137	144	167	172	180	190	196	199	179	138	138	133	124	24
25	117	99	66	53					31	73	79	120	142	148	166	171	169	170	159	147	167	172	139	129	25
26	110	81	52	35		30	32	31	47	57	88	129	138	157	204	158	205	209	184	159	148	145	138	109	26
27	86	86	59	50	34	26	23	36	34	55	87	94	115	173	187	196	203	170	171	148	180	164	159	118	27
28	111	96	82	51	42	34	31	41	48	89	89	129	148	170	173	191	210	257	231	199	188	194	159	126	28
29	101	88	59	44	31	33	26	34	40	62	78	132	136	182	182	176	210	192	174	183	177	139	155	136	29
30	126	84		65	55	42	42	48	46	65	86	95	124	131	157	199	193	220	187	204	166	164	122	118	30
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS

CHRISTCHURCH, NEW ZEALAND																									
AUGUST 1965																									
HOURLY ALL-SKY METEOR RATES CENTERED ON UNIVERSAL TIMES SHOWN...																									
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS
DAYS																									DAYS
1	101	81	63	29	29	27	27	37	38	79	106	215	248	292	359	367	337	343	247	231	189	132	107	91	1
2	79	80			31	30	29	22	47	63	99	159	222	292	309	325	324	290	224	205	164	139	127		2
3		85	57	53	43	27	18	32	46	87	127	186	216	252	336	365	327	337	250	189	164	152	132	108	3
4	84	75	68	39	31	30	31	29	41	65	109	151	187	252	226	198	235	146	171	150	135	92	104	118	4
5	117	86	54	42	31	38	30	37	42	78	118	166	193	235	297	308	356	272	220	197	178	150	118	150	5
6	90	89	46		38	20	28		38	57	78	100	149	235	210	211	206	178	174	177	128	139	101	79	6
7	76	61	66	32	29	21	21	30	38	69	83	94	159	176	178	192	231	205	194	151	128	81			7
8		53	43	39	38	21	24	34	27	65	91	111	134	169	221	245	234	169	209	159	145	97	142	118	8
9	94	85	71	38	40	31	22	31	30	67	83	120	146	166	210	211	225	200	188	157	142	114	113	105	9
10	103	76			43	34	27	22	43	52	80	129	156	184	234	219	250	221	202	173	159	144	126	106	10
11	108	83	45	45	37	27	34	24	36	62	74	122	152	173	166	171	202	164	141	131	133	126	133	124	11
12	91	62	34	31	31	25	21	26	45	49	65	111	129	153	172	198	152	198	164	132	141	125	110	105	12
13	78	83	44	50	39	28	21	28	38	44	68	90	150	166	173	176	177	174	164	121	152	129	132	96	13
14	84	66	65	50	39	27	28	26	28	51	80	101	159	157	197	213	232	214	185	160	139	160	137	100	14
15	92	79	63	40	34	41	25	37	38	58	90	123	156	175	233	215	217	200	196	156	152	152	127	93	15
16	92	60	49	42	26	26	26	28	32	55	88	116	142	157	186	172	208	203	145	145	101	110	110	109	16
17	94	61	63	41	41	28	31	34	38	33	53	91	123	142	169	198	173	141	173	112	127	127	109	91	17
18	77	70	53	49	24	22	23	23	41	42	73	93	104	142	149	191	158	164	171	123	121	122	98	77	18
19	72	65		28	21	19	17	21	28	28	64	100	125	129	188	149	166	159	138	127	151	113	112	112	19
20	70	67	57	27	32	28	13	29	19	57	57	99	111	162	147	161	156	144	122	122	106	88	111	69	20
21	74	91	49	41	29	34	28	23	38	42	58	88	108	135	145	175	135	147	136	107	108	101	91	77	21
22	80	50	48	24	21	19	19	24	35	39	60	106	104	120	143	153	146	142	111	113	102	106	113	82	22
23	82	57		46	31	26	17	13	23	40	50	82	99	126	116	118	118	129	109	74	81	82	92	81	23
24	69	74	55	31	22	26	18	28	36	40	68	107	130	145	161	160	139	170	148	126	90	97	103	93	24
25	74			38	33	28	31	21	36	45	67	84	114	162	175	153	184	146	139	138	140	115	86	93	25
26	78	74		29	18	19	22	20	30	47	73	81	106	107	136	137	147	137	128	122	99	102	101	95	26
27	70	55	43	35	21	26	15	24	27	43	53	89	111	130	152	189	159	144	134	137	137	126	107	88	27
28	78	84	65	45	30	31	28	25	28	40	64	89	125	158	138	165	132	180	172	129	116	108	94	89	28
29	75	87	71	32	24	28	22	16	33	47	49	71	136	135	159	139	178	146	141	137	137	144	118	94	29
30	74	78			13	19	22	24	24	26	54	84	88	127	165	162	162	139	130	134	151	89	94	103	30
31	81	70	56	36	37	19	24	26	26	35	54	86	96	131	160	142	156	146	128	116	116	100	116	80	31
HOURS	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	HOURS

METEOR DATA SUMMARY

In this table the first figure is the monthly meteor total and it is followed by the number of half-hourly counts added to form the total.

	1963		1964		1965	
January	-	-	90341	1294	75425	1382
February	65386	1088	74231	1249	64370	1168
March	63680	1078	65487	1235	64486	1258
April	84704	1326	65010	1237	69721	1221
May	101666	1354	67304	1426	89638	1413
June	112358	1421	72548	1211	98009	1412
July	113739	1408	63831	1381	111205	1463
August	90507	1460	58510	1343	78071	1459
September	63571	1386	34306	963	-	-
October	48332	1182	48175	1320	-	-
November	69202	1401	44928	1269	-	-
December	89087	1366	66505	1354	-	-
Annual Totals	902232	14470	751176	15282	650925	10776

Total meteors recorded: 2304333

Total hours observed: 20264

Average hourly meteor rate: 113.7

7. THE ANNUAL AND DIURNAL VARIATIONS

The hourly meteor rates, averaged throughout every day for a third of a month, are shown for the whole period of the survey in Figure 5. Apart from an inexplicable fluctuation in March 1964 the form of the annual variation is similar for each year. The overall level of activity varies from year to year with the years of the 1963/65 survey showing a higher level of activity than that during the 1960/61 survey. This was most marked during the months of May, June, and July, when the 1963 rates were over 100 per cent greater than in 1960 (Ellyett & Keay, 1964). A concurrent increase in meteor rates observed in Canada (McIntosh & Millman, 1964) and Sweden (Lindblad, 1967) confirmed the reality of the effect which was subsequently attributed to variations in atmospheric density inversely related to solar cycle activity (Lindblad, 1967; Ellyett, 1968).

Except for an overall increase of approximately 40 per cent the mean diurnal variation in meteor rates closely resembles that observed during the 1960/61 survey, as may be seen from Figure 6. The diurnal minimum near 18^hL.T. is shifted by approximately 20^m because the 1963/65 curve includes data from an incomplete year of observations, i.e. 31 months instead of a multiple of twelve months, and the fact that there is a pronounced shift in the time of the diurnal minimum in the course of a year (see Figure 13).

The month-by-month changes in the shape of the diurnal variation in meteor activity are shown in Figures 7 to 10. Each year (including 1960/61) is shown separately in these figures and in most cases there is more similarity in shape between corresponding months of each year than between adjacent months. This fact provides strong evidence that the changes in observed level of meteor activity from year to year are not caused by any variations in the influx rate of small meteoroids. This does not, of course, preclude the chance of quite large fluctuations in activity over short periods of the order of days or weeks.

The times of day when the meteor rates reach their extreme values, and the magnitudes of these extremes, alter considerably during the year. The maximum and minimum rates are shown in Figure 11 revealing a pronounced seasonal variation despite the large changes in the level of activity from year to year. The seasonal variation is produced by the tilt of the Earth's axis together with any non-uniformity in the distribution of intercepted meteoroids around the Earth's orbit. The large first harmonic component in the latter distribution (Keay, 1963) combines with the effect of the axial tilt to yield a roughly sinusoidal seasonal variation shifted about one month out of phase with the equinoxes.

The greatest distortion of the sinusoidal curve occurs during the winter months in the Southern Hemisphere, when showers such as the Delta Aquarids and Arietids are active. In years when the air density of the lower thermosphere is high the electron densities in meteor trails are increased, bringing fainter meteors within the radar detection threshold. The above showers are known to be rich in small meteoroids (e.g. Weiss, 1957), hence the observed meteor echo rates increase more markedly than for other well-known showers when the air density is greater than usual.

Although there is considerable variation in the extremum rates from year to year, the ratio of the maximum to minimum diurnal rates shows far less scatter, as may be seen from Figure 12. This confirms that the meteor rates are influenced independently of the time of day by the factors which cause the year-to-year rate variations, as would be the case with large variations in the density of the upper atmosphere. The diurnal maximum/minimum rate ratio exhibits a simple seasonal variation almost sinusoidal in form, but perturbed by a large increase at the time of the Delta Aquarid shower in late July-August, when the ratio climbs from about 6 to over 10. Otherwise the ratio ranges from a minimum of 3 in autumn (Southern) to approximately 6 in

spring. By far the greater part of this variation is produced by the axial tilt of the Earth. In springtime, when the antapex reaches its maximum elevation for the year, the observing location is shielded from all except the few meteoroids which overtake the Earth, and the diurnal minimum meteor rate is at its lowest. The diurnal maximum is altered far less by this effect and therefore the diurnal maximum/minimum rate ratio would be greatest in the spring in the absence of major shower activity.

The time of day at which the diurnal minimum occurs varies by nearly two hours during the course of the year. This variation also occurs in a regular manner, as may be seen from Figure 13, and is attributable to the same agency, namely the tilt of the Earth's polar axis plus the effect of the concentration of meteoroid orbits within about fifteen degrees of the plane of the ecliptic as seen from the Earth. Although the antapex is in transit at 18^hL.T. the elevation of the ecliptic is diminishing at that hour in summer (December in the Southern Hemisphere) and is increasing in winter, causing the time of the diurnal minimum to be later in summer and earlier in winter. The greatest perturbation to the curve arises in the summer months and is probably related to the greater incidence of meteoroids in high inclination orbits observed at that time (Nilsson, 1964). Their effect would be to restore the time of the diurnal minimum to nearer 18^hL.T., the time of transit of the antapex, and this is what is in fact observed in Figure 13.

The time of day when the maximum meteor rate is observed can vary widely and in many cases the maximum is very broad, extending over six hours or more; or is a double maximum, as in February and March of 1963 and 1965. When a distinct peak occurs it can be as early as 3^hL.T. or as late as 10^hL.T. This variability reflects the changes throughout the year in the preponderant direction of arrival of the incident meteoroids and will be the subject of further analysis.

8. NOISE EFFECTS

As noted earlier (Section 2) readings were taken of the receiver detector current at three minute intervals. These readings indicated the intensity of noise entering the receiver. If the readings are averaged over periods of a week or more to suppress random contributions from other sources such as solar noise and man-made interference, the sidereal periodicity of galactic noise is quite apparent.

The two upper curves in Figure 14 show the half-hourly mean values of the detector currents averaged over the two year period from February 1963 to January 1965 inclusive. Curves derived from data obtained over the two year period from September 1963 until the end of the survey are closely similar. For the top curve the average has been derived for half-hour intervals of solar time, and the diurnal variation does not exceed 5 per cent. For the middle curve sidereal time has been used, revealing a sidereal variation which is much greater than any diurnal effect. This is to be expected because the galactic centre culminates close to the zenith at mid-southern latitudes and its radio emission is readily received by the omni-directional antenna used for the meteor survey.

The sidereal variation in galactic noise affects the sensitivity of the receiver and hence the limiting magnitude of the meteors detected. This leads to a small sidereal variation in the meteor rate, as may be seen from the lower curve in Figure 14. The curve shows a variation by a factor of 1.56 but some of this results from the large diurnal variation in meteor rate already shown in Figure 14. The extent of the sidereal variation in meteor rate caused by galactic noise is at present under study.

However if all of the variation is ascribed to galactic noise, the limiting meteor magnitude detectable by the equipment is altered by less than half a magnitude.

This can be shown by assuming that the cumulative meteor distribution function $N(q_z)$ can be represented by a simple power law of the form

$$N(q_z) = Kq_z^{1-s}$$

where $N(q_z)$ is the number of meteors producing zenithal line densities greater than q_z electrons per metre, and s the power law exponent. Using the definition for radio magnitude

$$M_R = 40 - 2.5 \log_{10} q_z$$

the incremental magnitude dM_R is therefore

$$dM_R = \frac{1.085}{1-s} \cdot \frac{dN(q_z)}{N(q_z)}$$

From Figure 14, $dN/N \approx 0.36$ and s is close to 2 for sporadic meteors of radio magnitude near +8 (Weiss 1961, Kaiser 1961) giving $dM_R = -0.4$. This means that at worst the effect of galactic noise would be to reduce the limiting zenithal meteor magnitude detectable by the Christchurch equipment from +8.2 (Keay, 1963) to +7.8. The actual value of dM_R appears likely to be less than -0.2 magnitudes — a result which will be published when a full study of the problem is completed. The meteors most frequently recorded by the radar equipment (refer Keay 1963, p.169) would therefore have zenithal radio magnitudes very close to +6.0, corresponding to meteoroids having a diameter of approximately 0.7 mm and a mass of the order of 1 milligram.

9. ACKNOWLEDGMENTS

The early stages of this work were supported by grant NSF-G24444 from the National Science Foundation, U.S.A. The survey program and subsequent data analysis could not have been completed without the financial support given by the U.S. National Aeronautics and Space Administration under grant NGR-52-052-001 to the University of Newcastle.

This project was given free use of the facilities of the University of Canterbury, New Zealand, where the equipment was operated, and the University of Newcastle, N.S.W., Australia, where the results were analysed and compiled.

The authors owe thanks to the many film-readers who patiently read and often re-read the 23,000 feet of film exposed during the survey.

Particular recognition is due to Messrs. E.C. McLauchlan, P.W. McNabb and L.E. Hunter for their continued maintenance of the radar system throughout the long period of operation.

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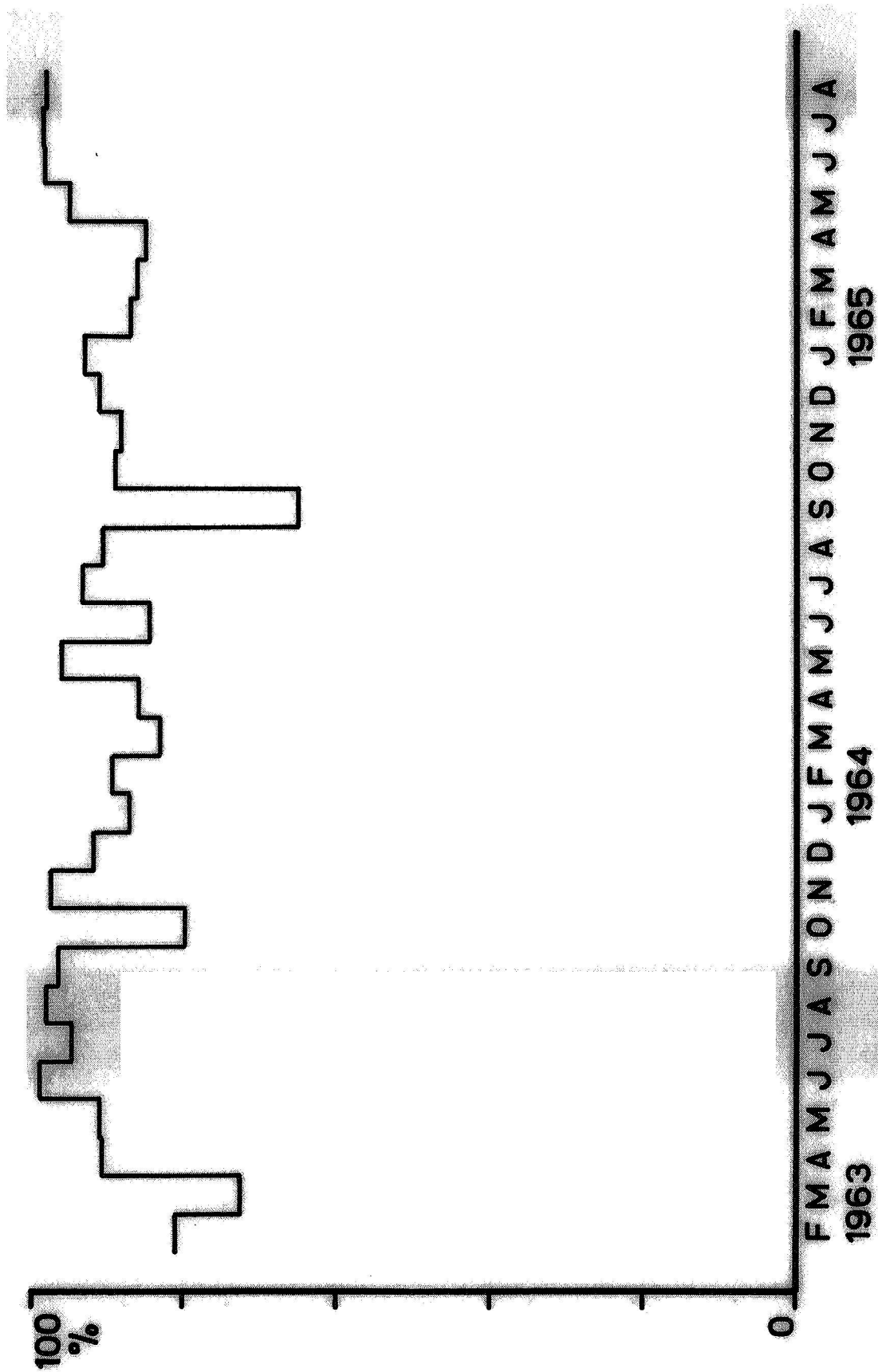


Fig. 1. Final tabulated data coverage throughout the survey.

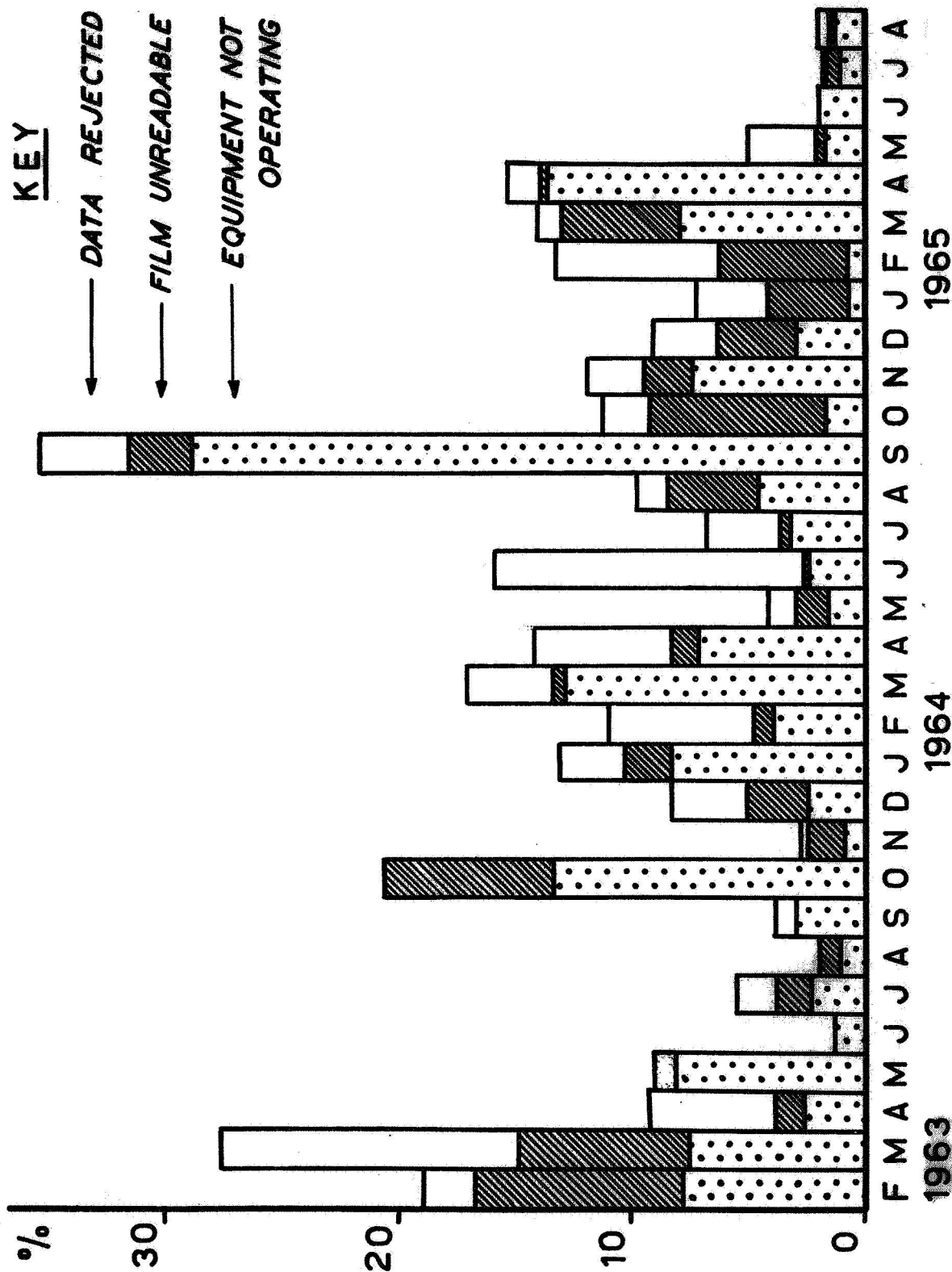


Fig. 2. Factors causing loss of data.

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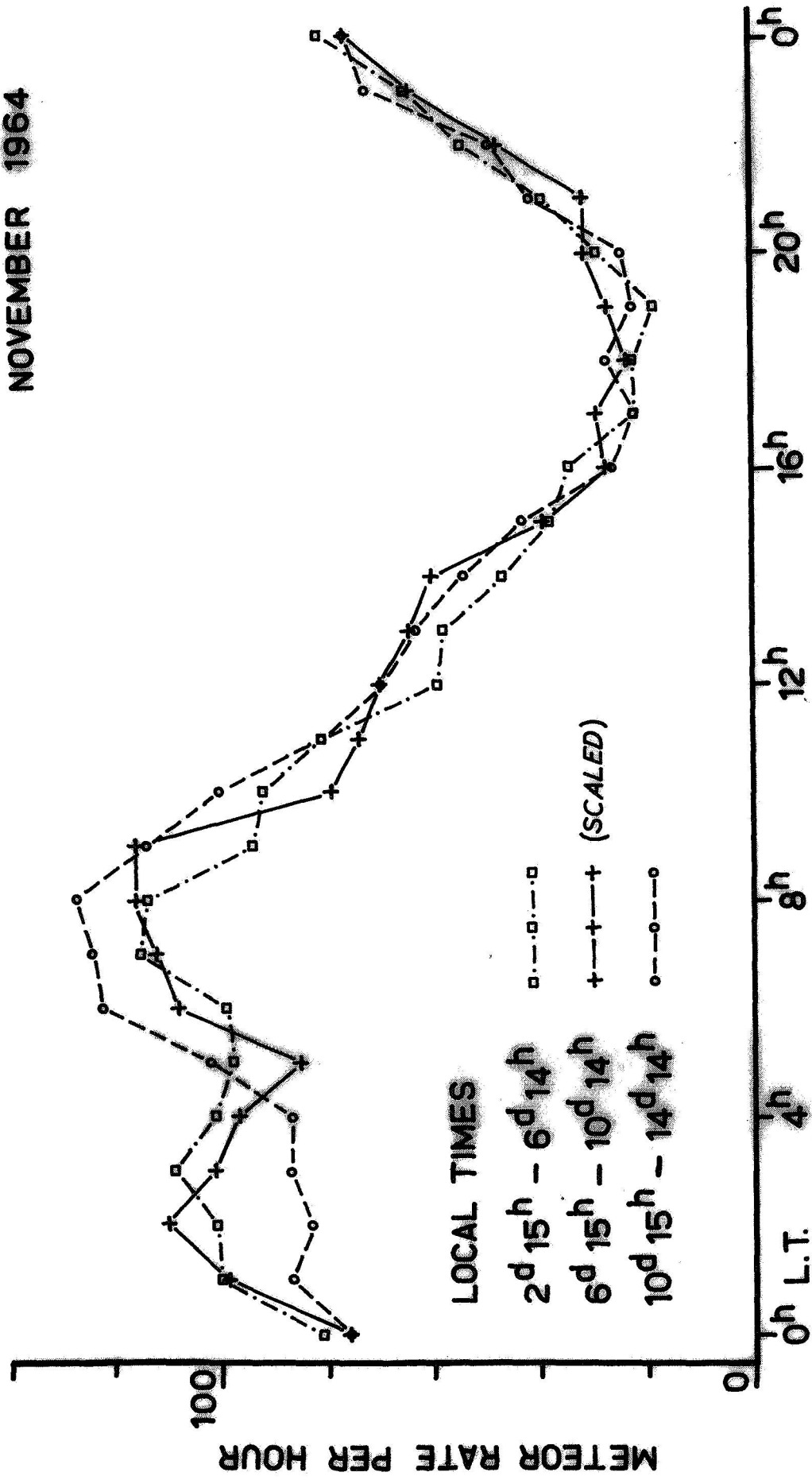
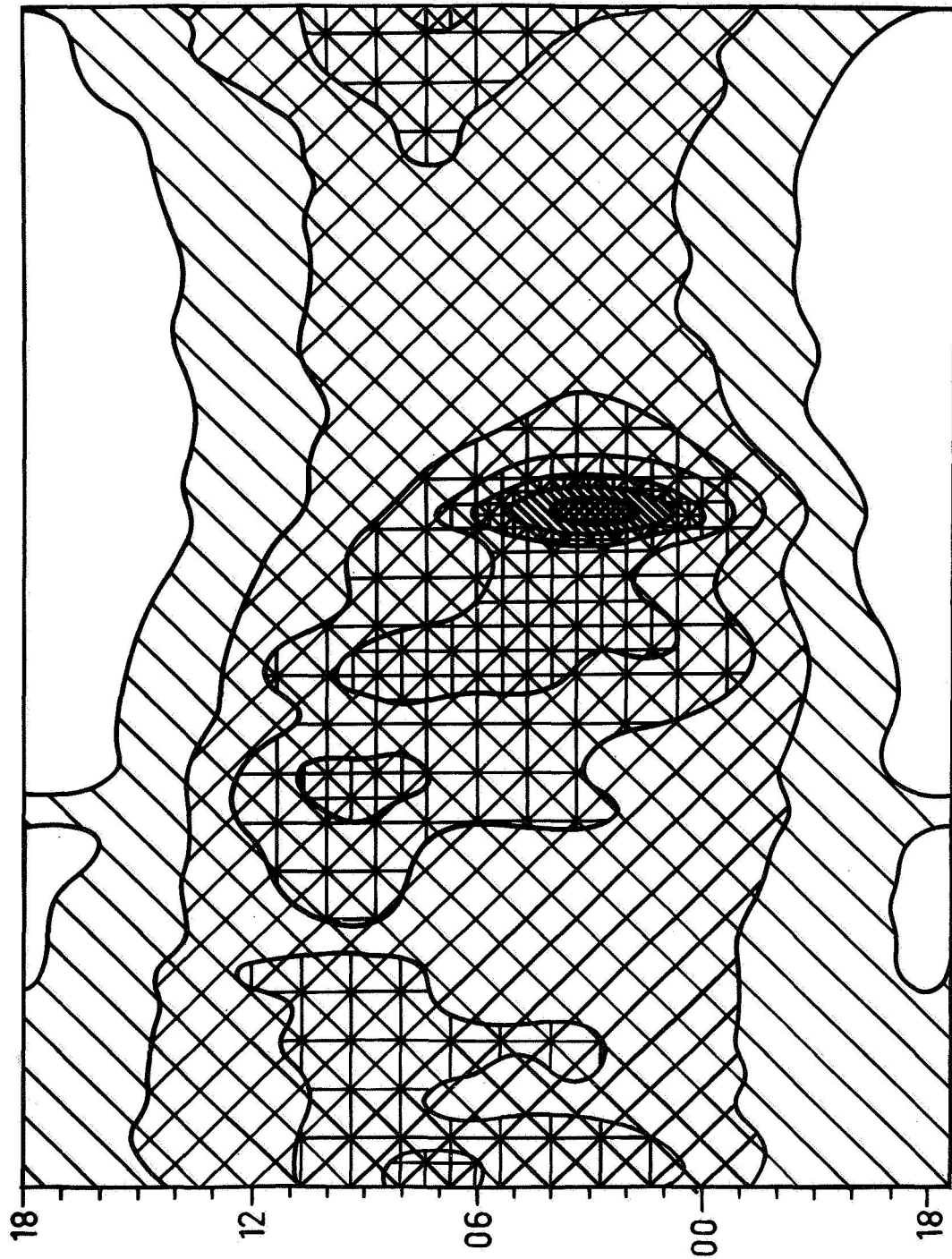
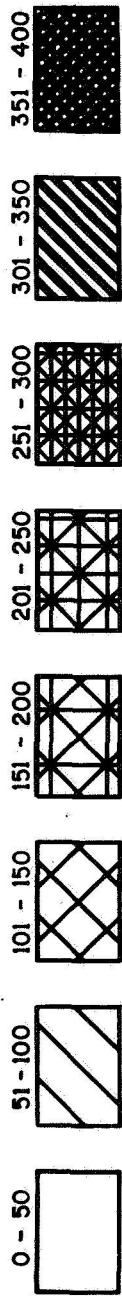


Fig. 3. Hourly meteor rates in November, 1964, showing scaled rates



JAN.FEB. | MAR. | APR. | MAY | JUN. | JUL. | AUG. | SEP. | OCT. | NOV. | DEC.

Fig. 4. Contour plot of hourly meteor rates, as a function of hour of day and time of year averaged over the period 1 Feb 1963 - 31 Aug 1965.

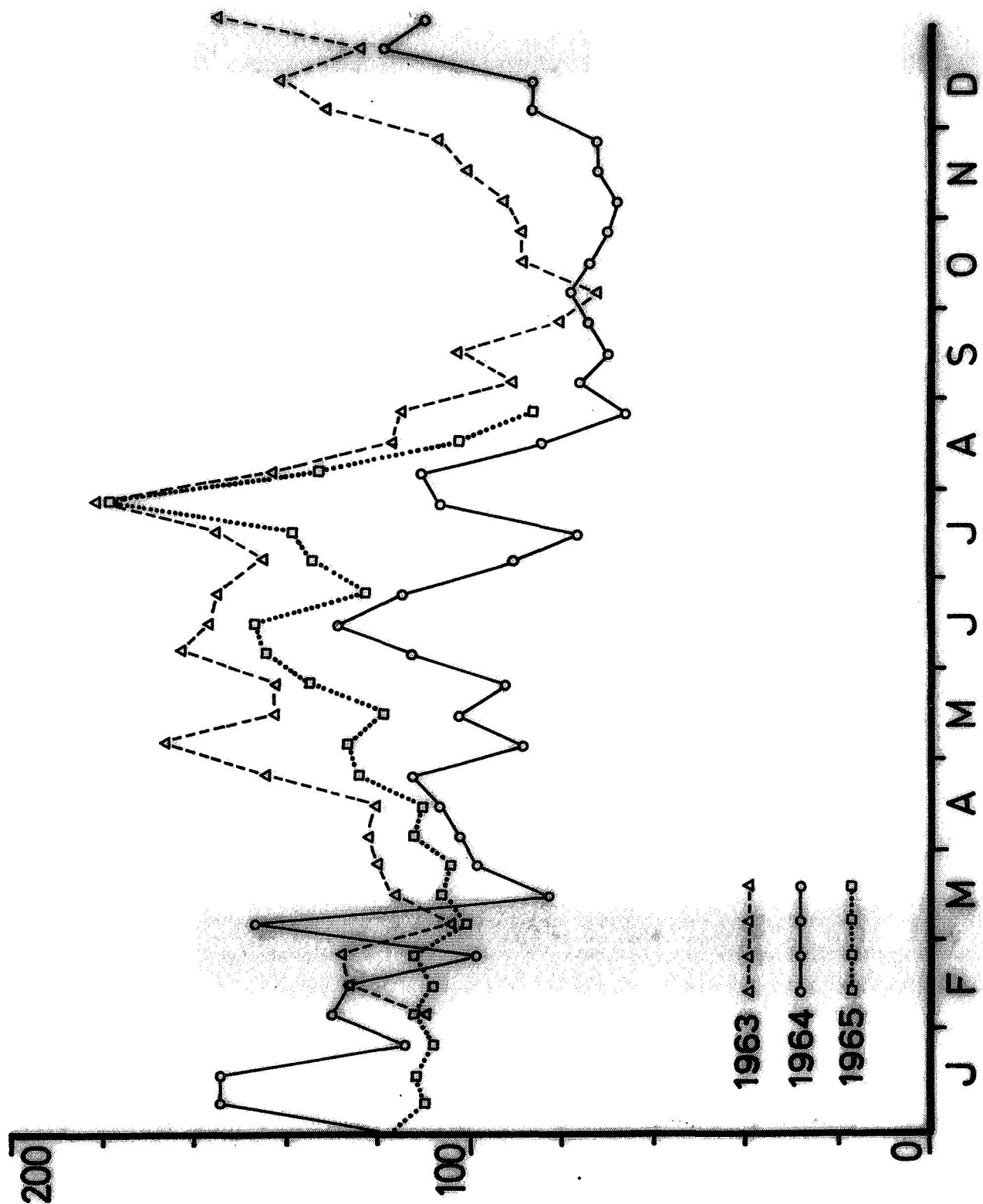


Fig. 5. Annual variation in average hourly meteor rate, at one third of a month intervals covering the period 1 Feb. 1963 - 31 Aug. 1965.

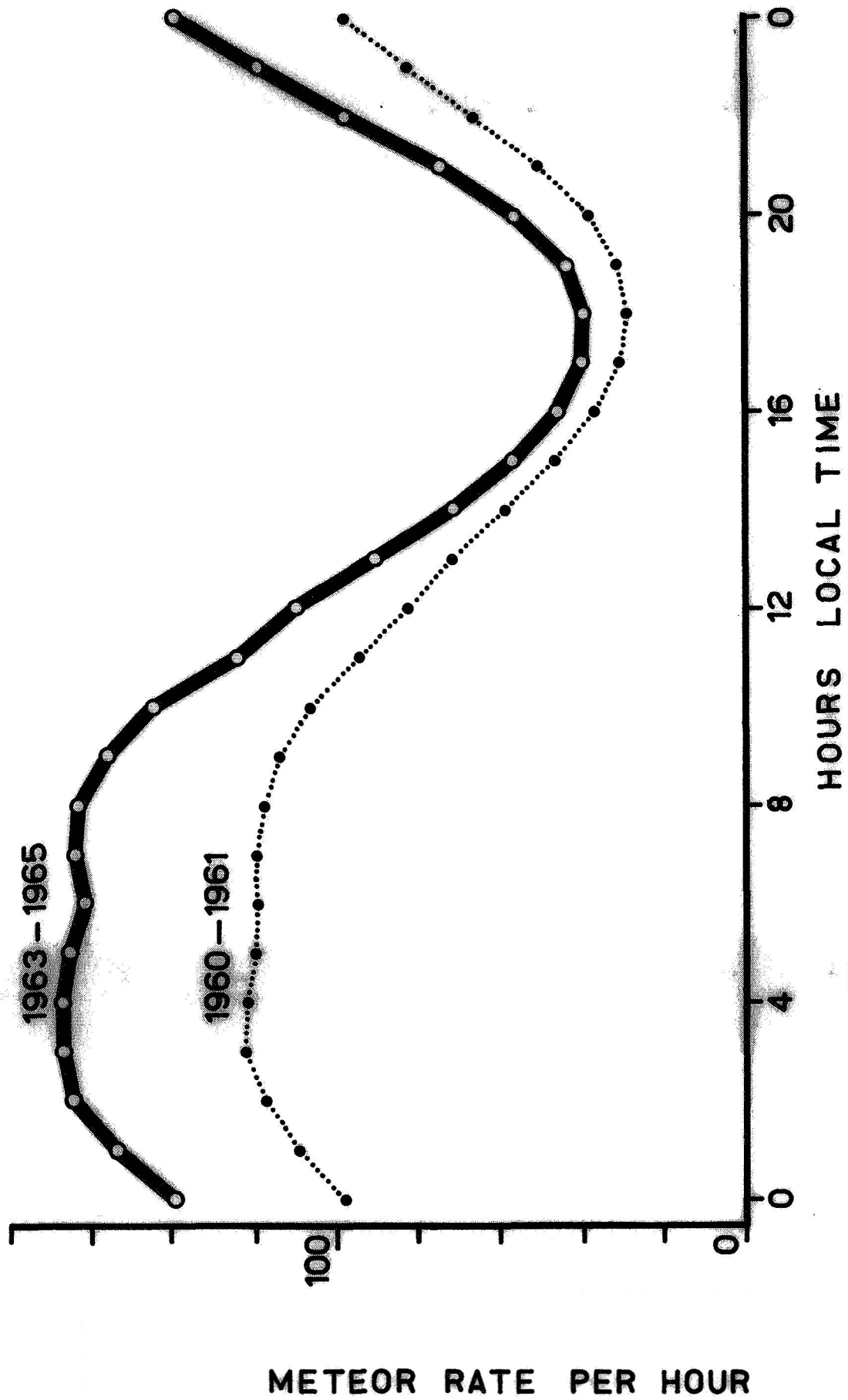


Fig. 6. Average diurnal variation in hourly meteor rate.

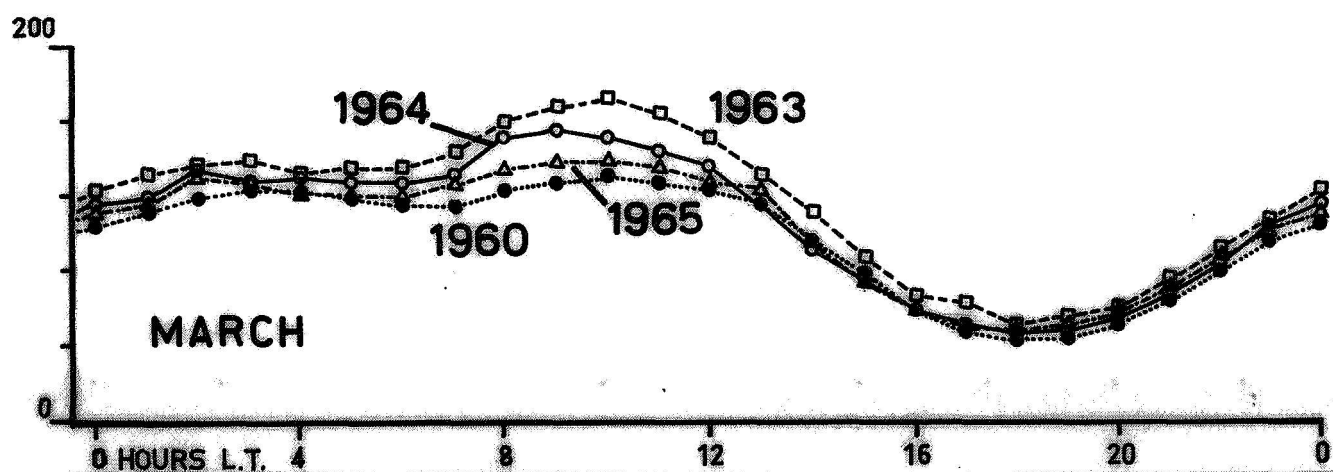
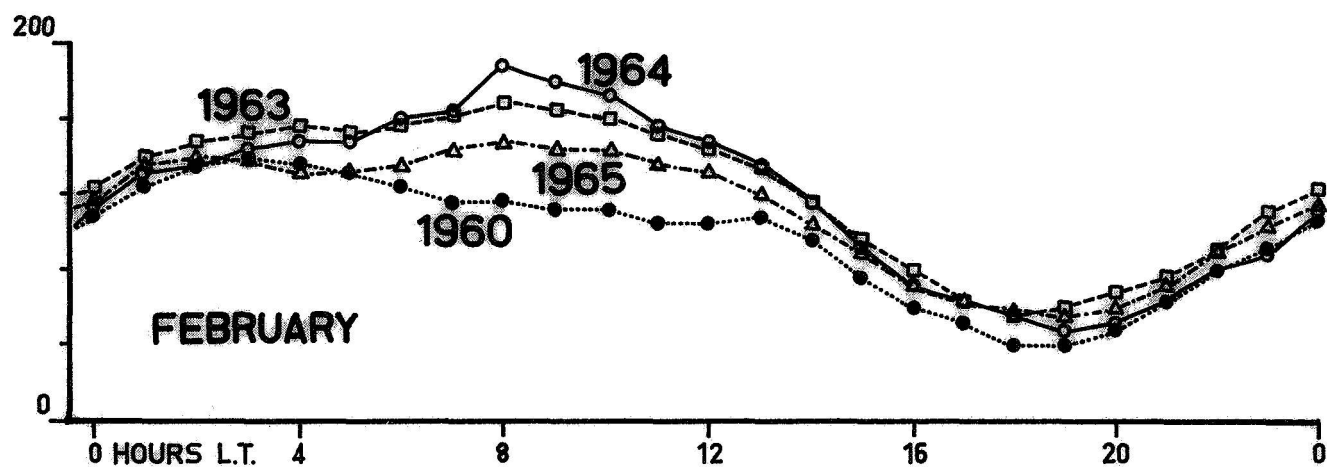
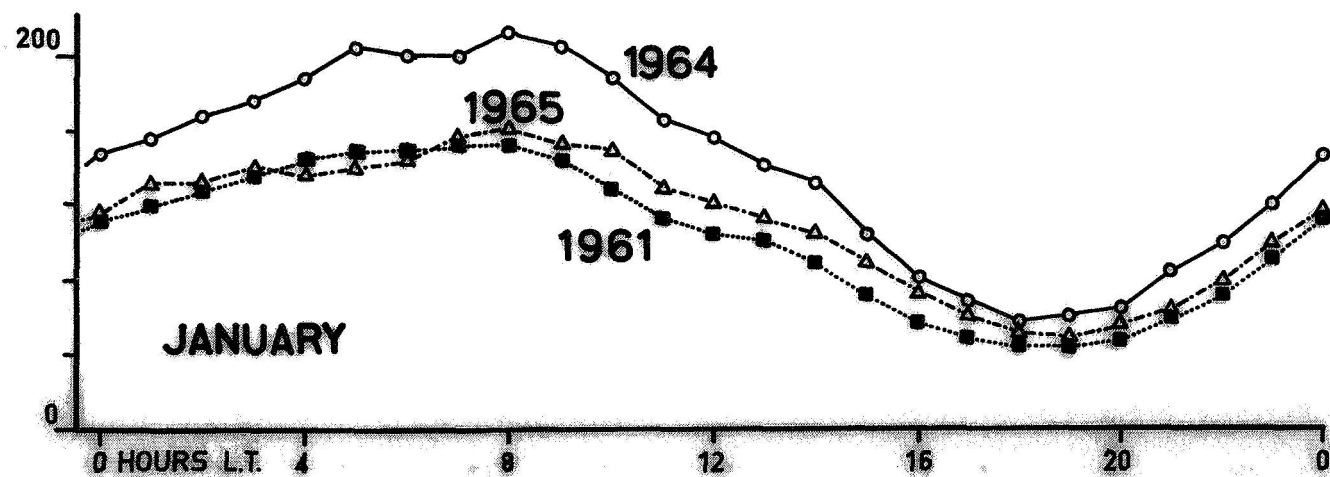


Fig. 7. Diurnal variation in hourly meteor rate for the months Jan, Feb, Mar.

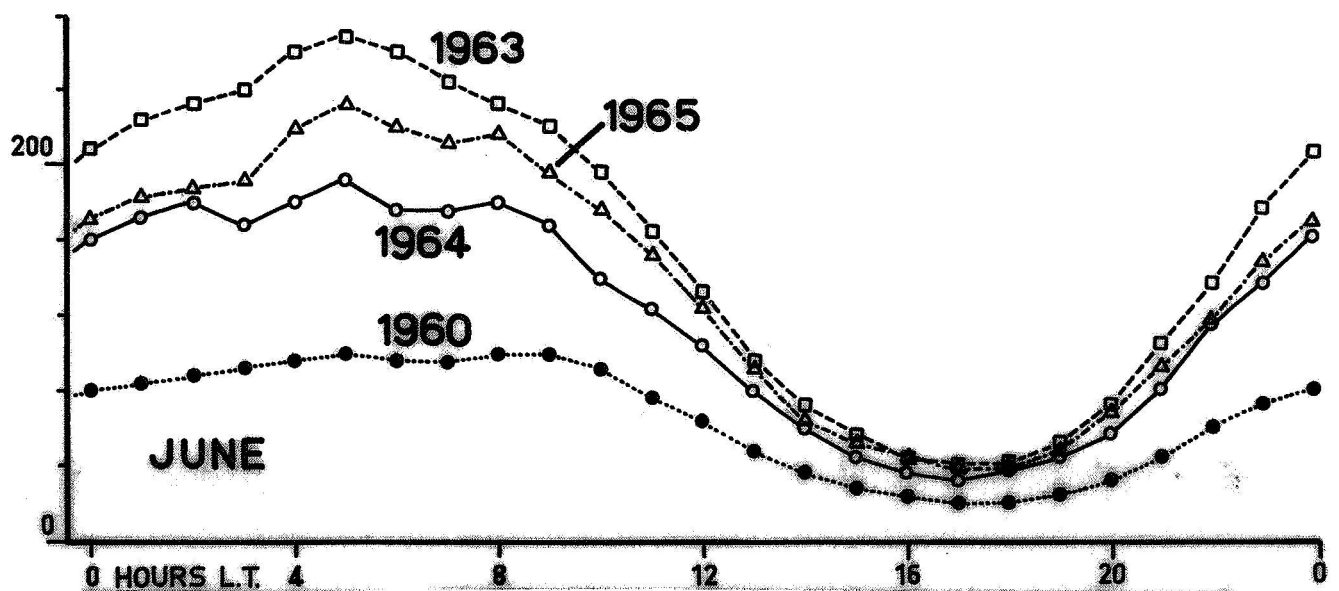
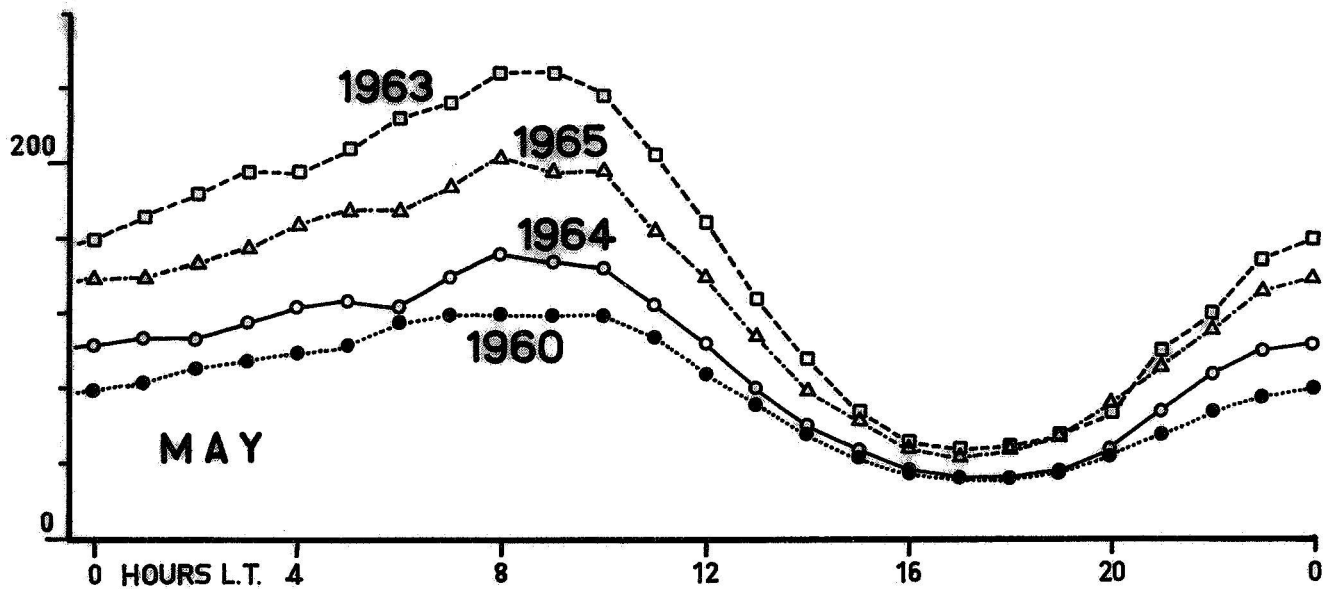
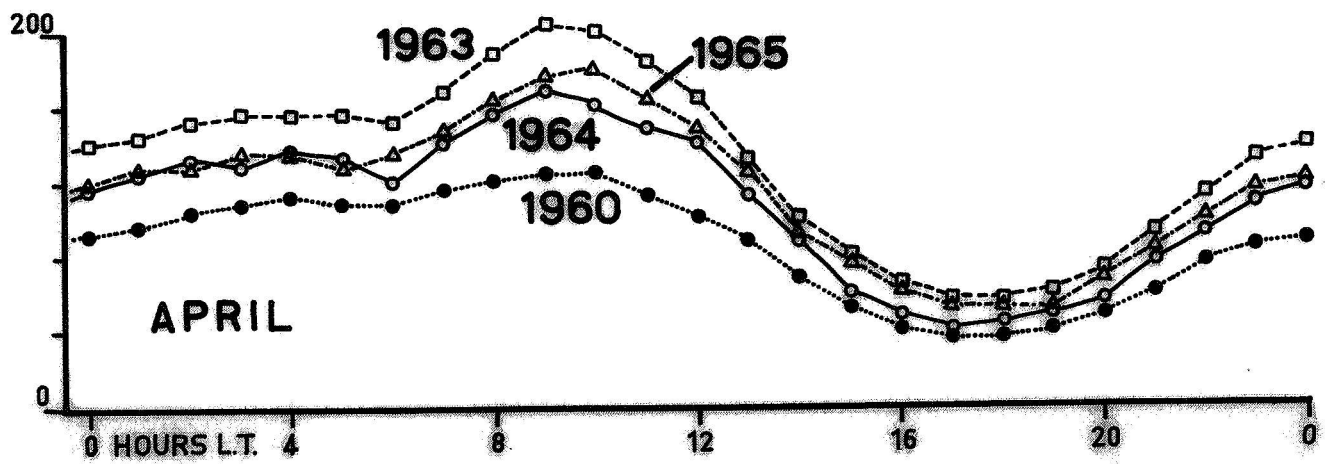


Fig. 8. Diurnal variation in hourly meteor rate for the months Apr, May, Jun.

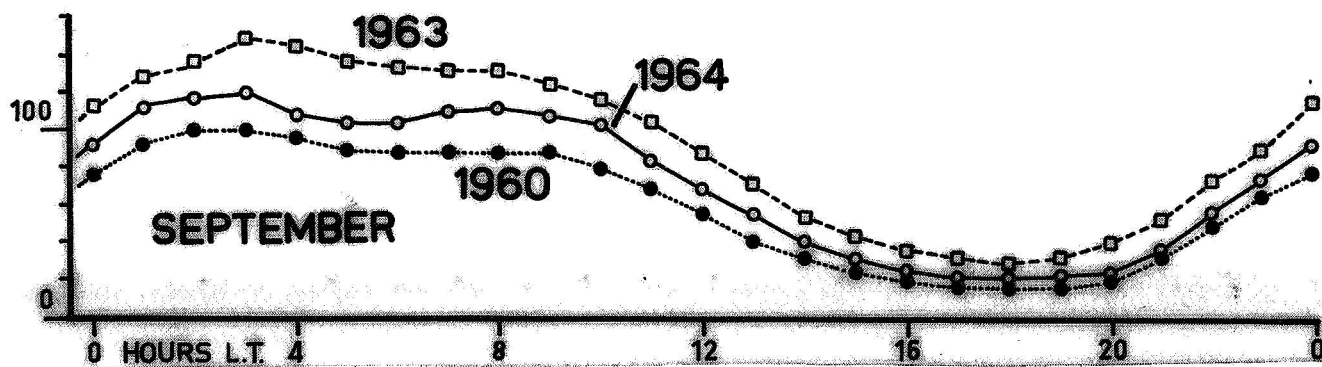
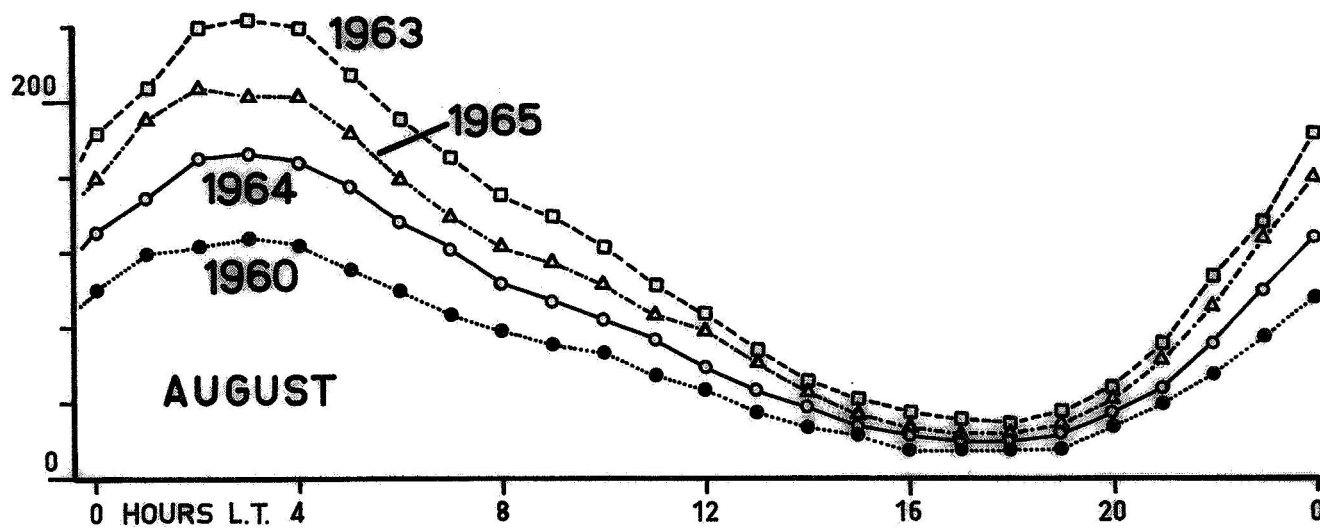
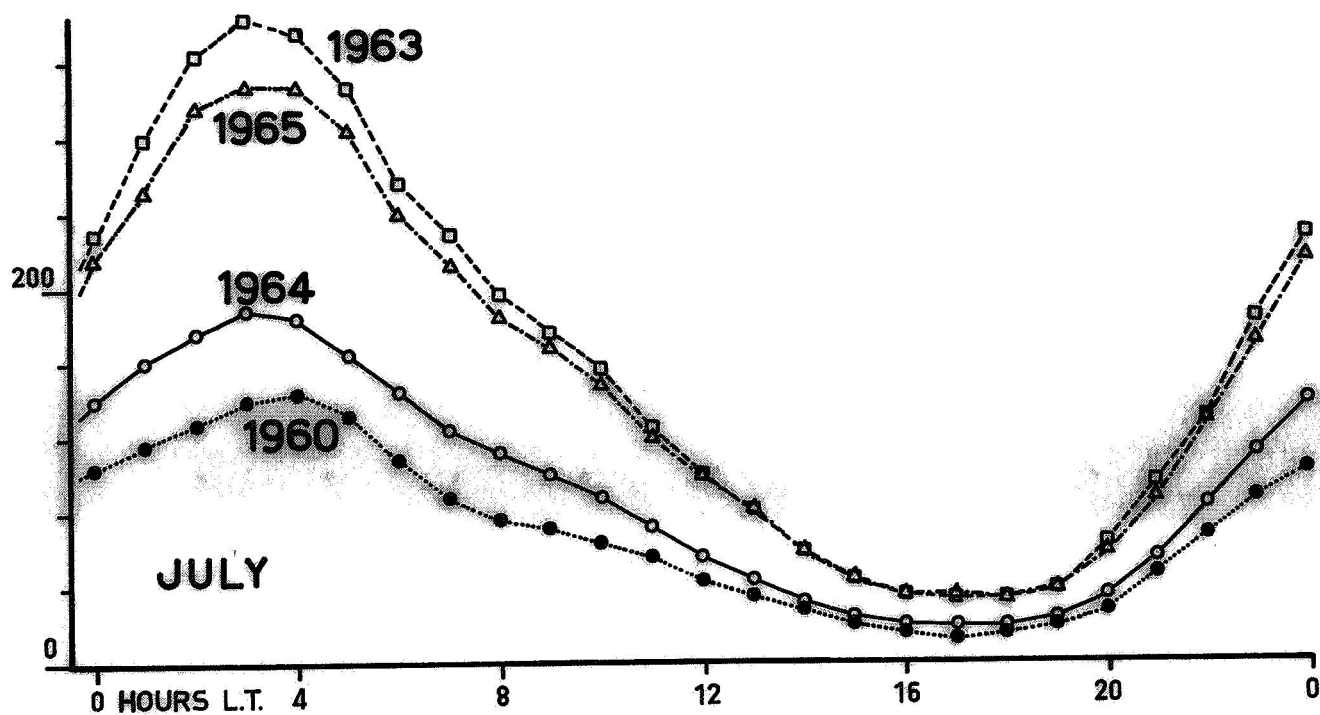


Fig. 9. Diurnal variation in hourly meteor rate for the months Jul, Aug, Sep.

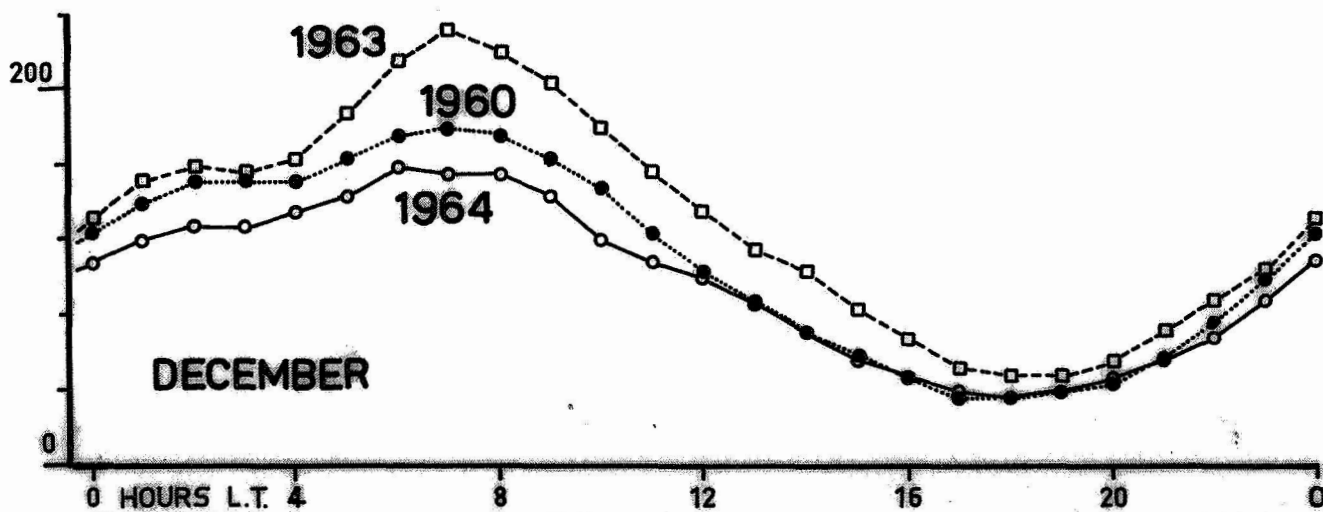
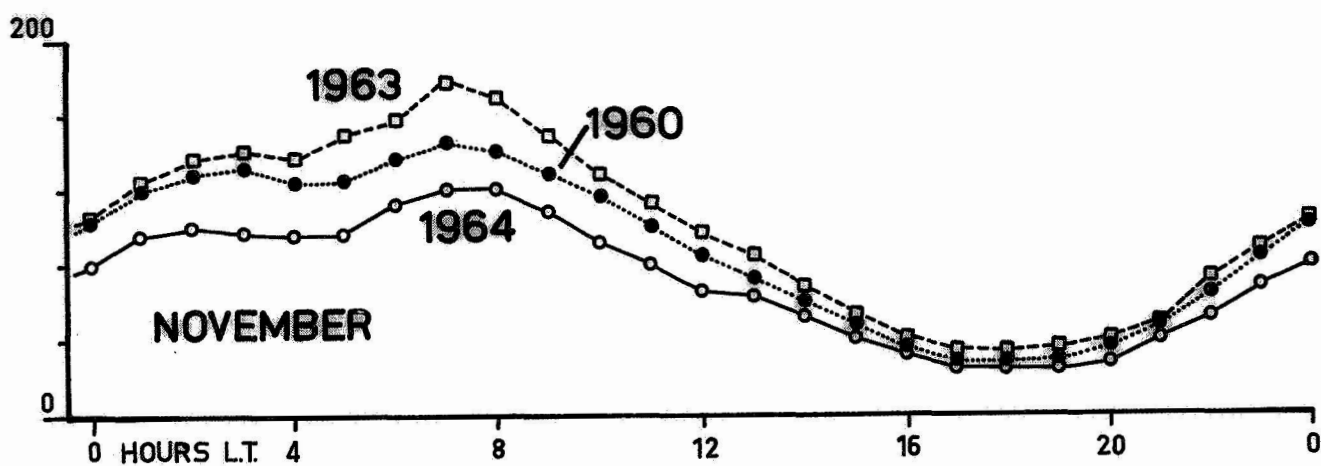
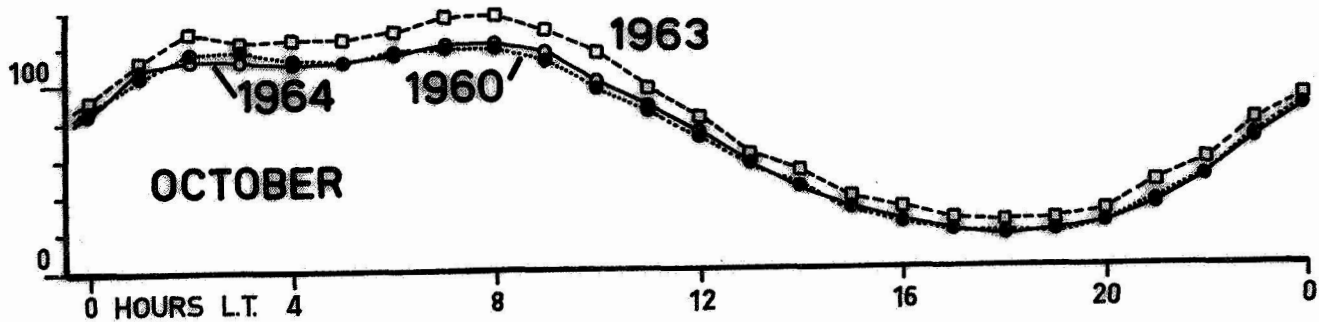


Fig. 10. Diurnal variation in hourly meteor rate for the months Oct, Nov, Dec.

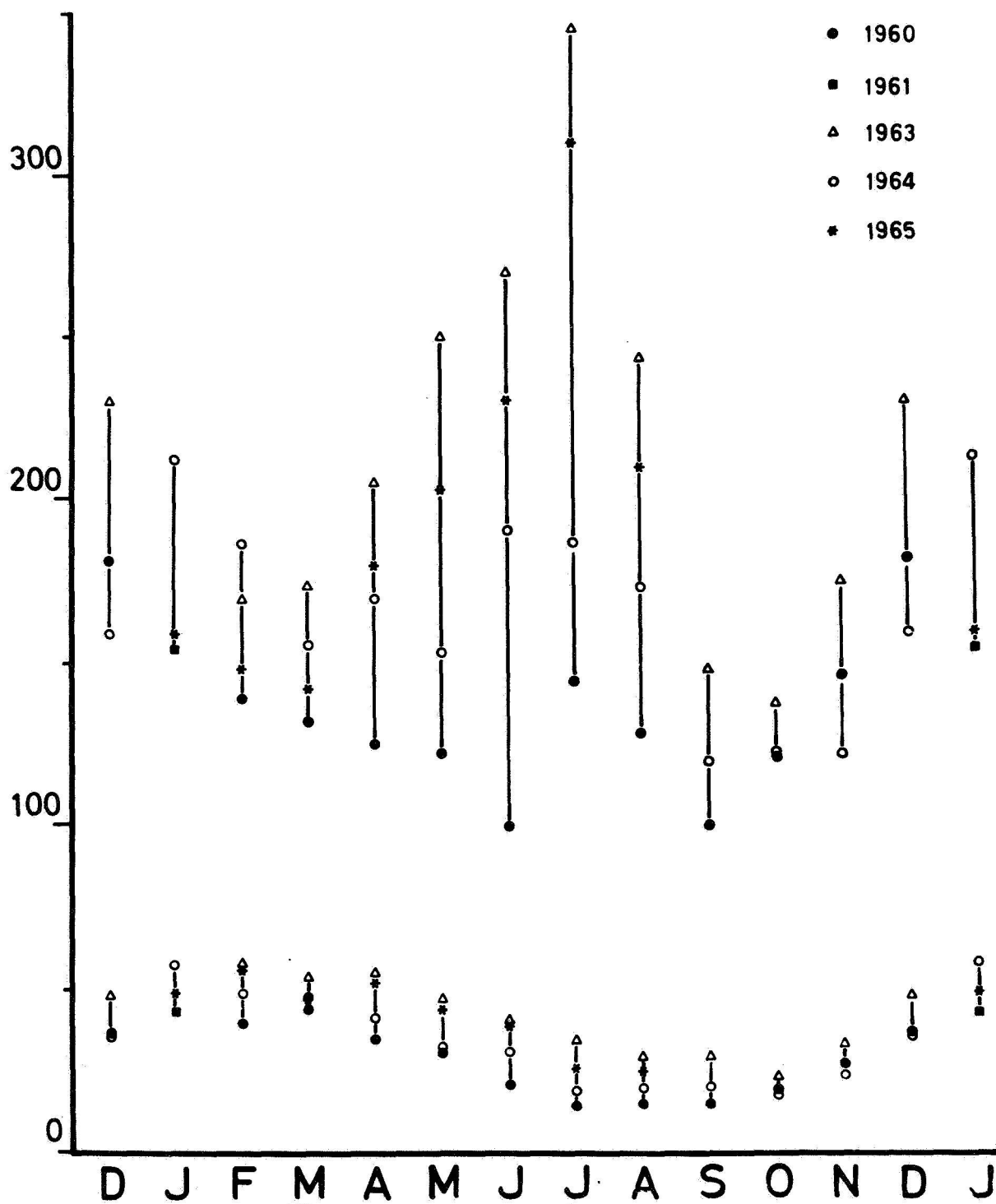


Fig. 11. Monthly maximum and minimum meteor rates per hour.

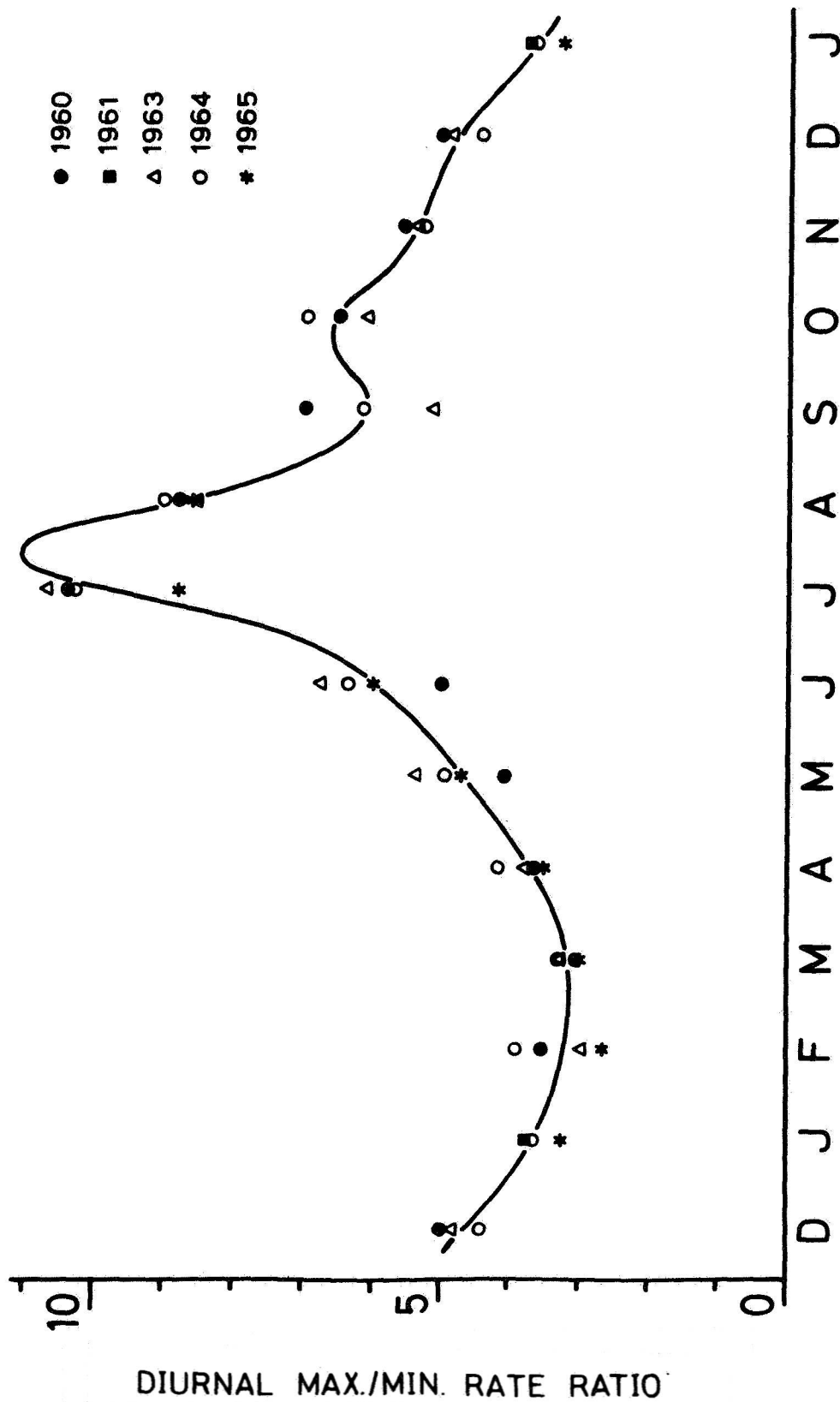


Fig. 12. Annual variation in the diurnal ratio of maximum to minimum meteor rates.

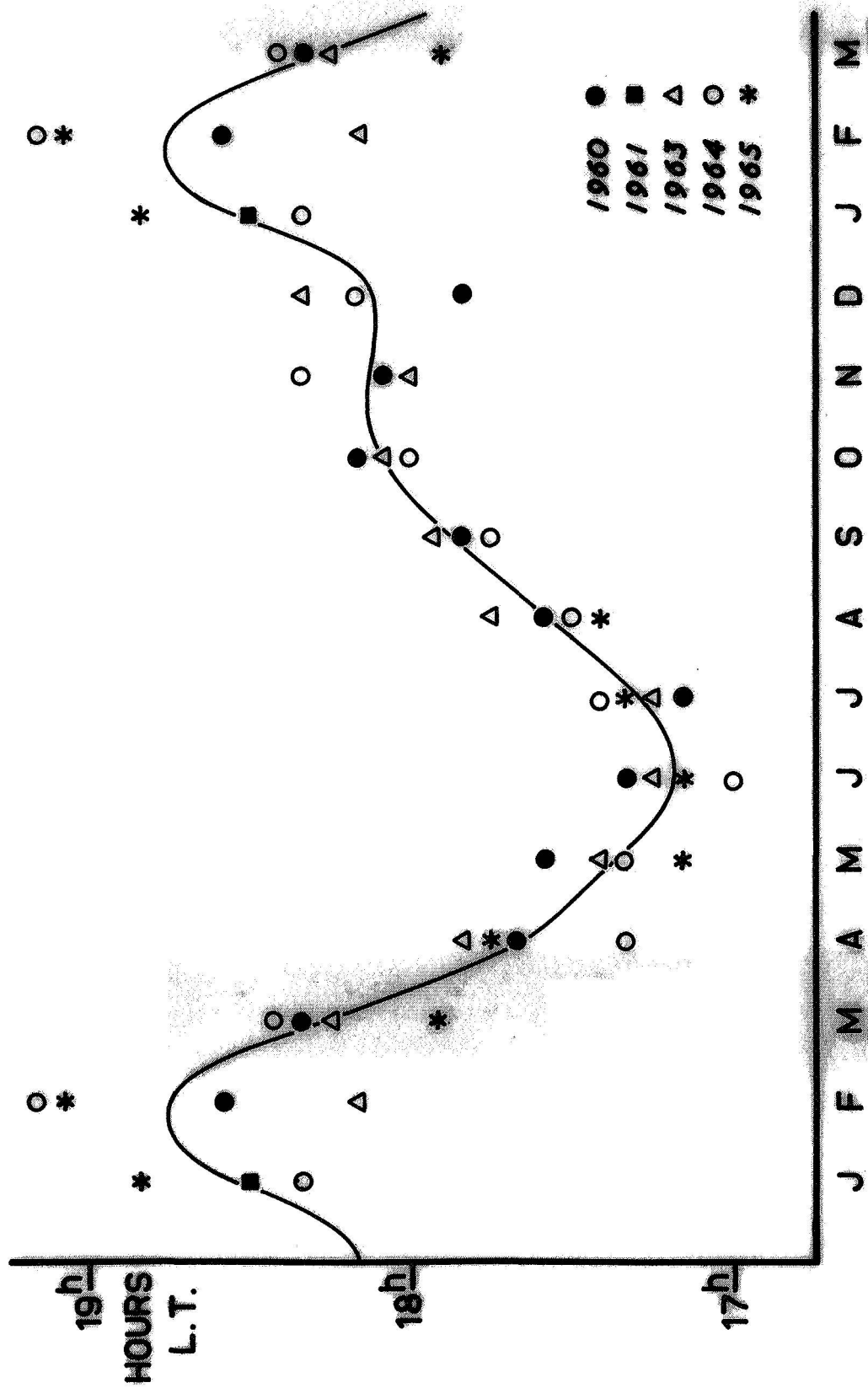


Fig. 13. Annual variation in the time of occurrence of the diurnal minimum meteor rate.

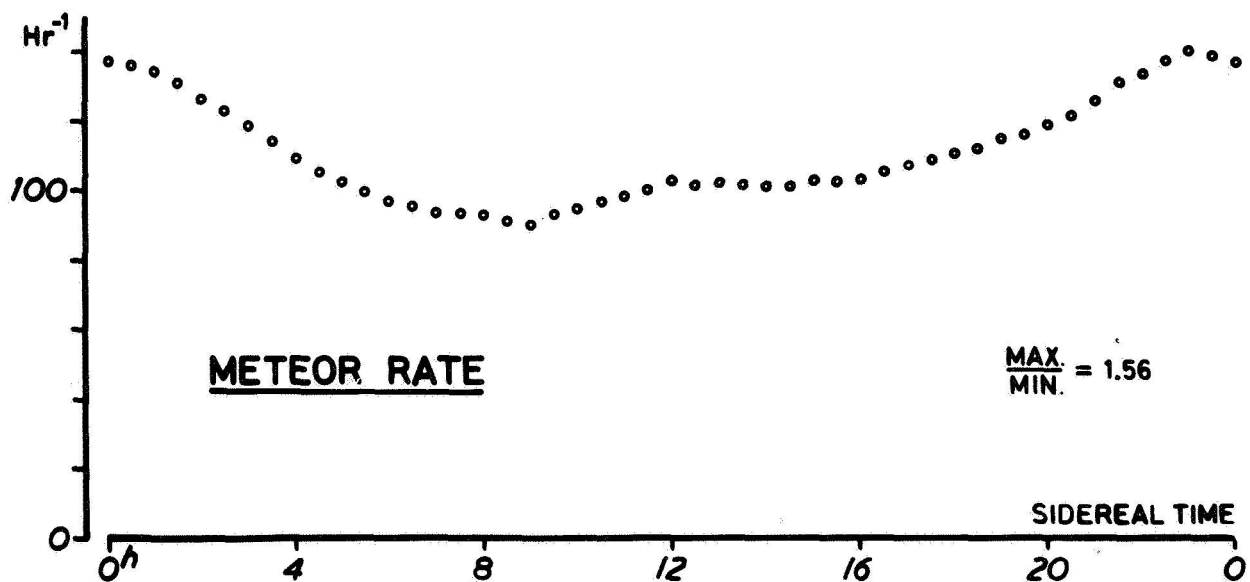
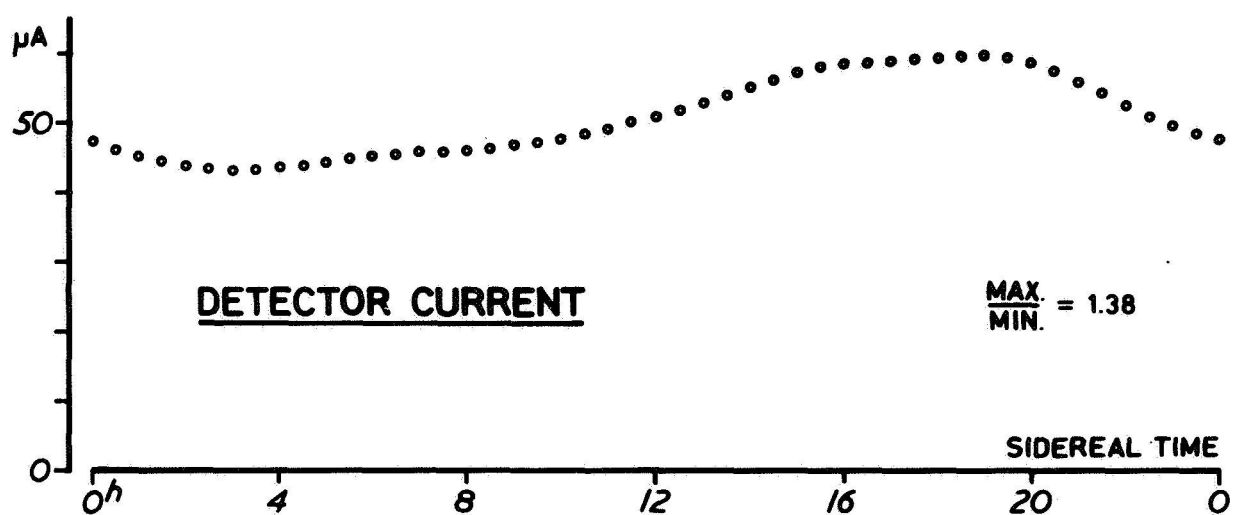
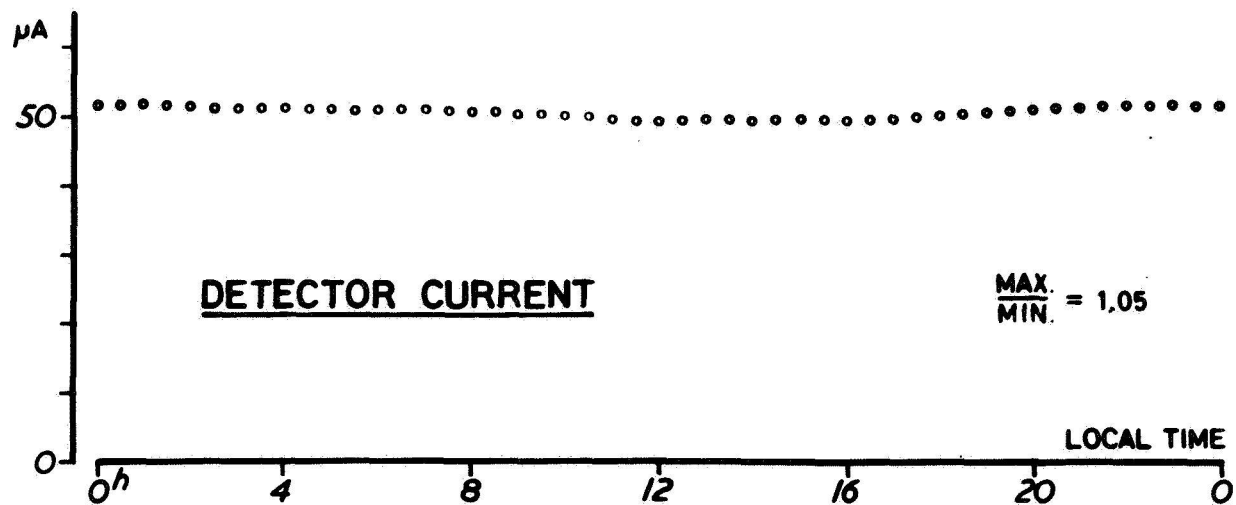


Fig. 14. The sidereal variation in detector current and meteor rate averaged over the two-year period Feb. 1963 to Jan. 1965, inclusive. The diurnal variation in detector current is shown for comparison.